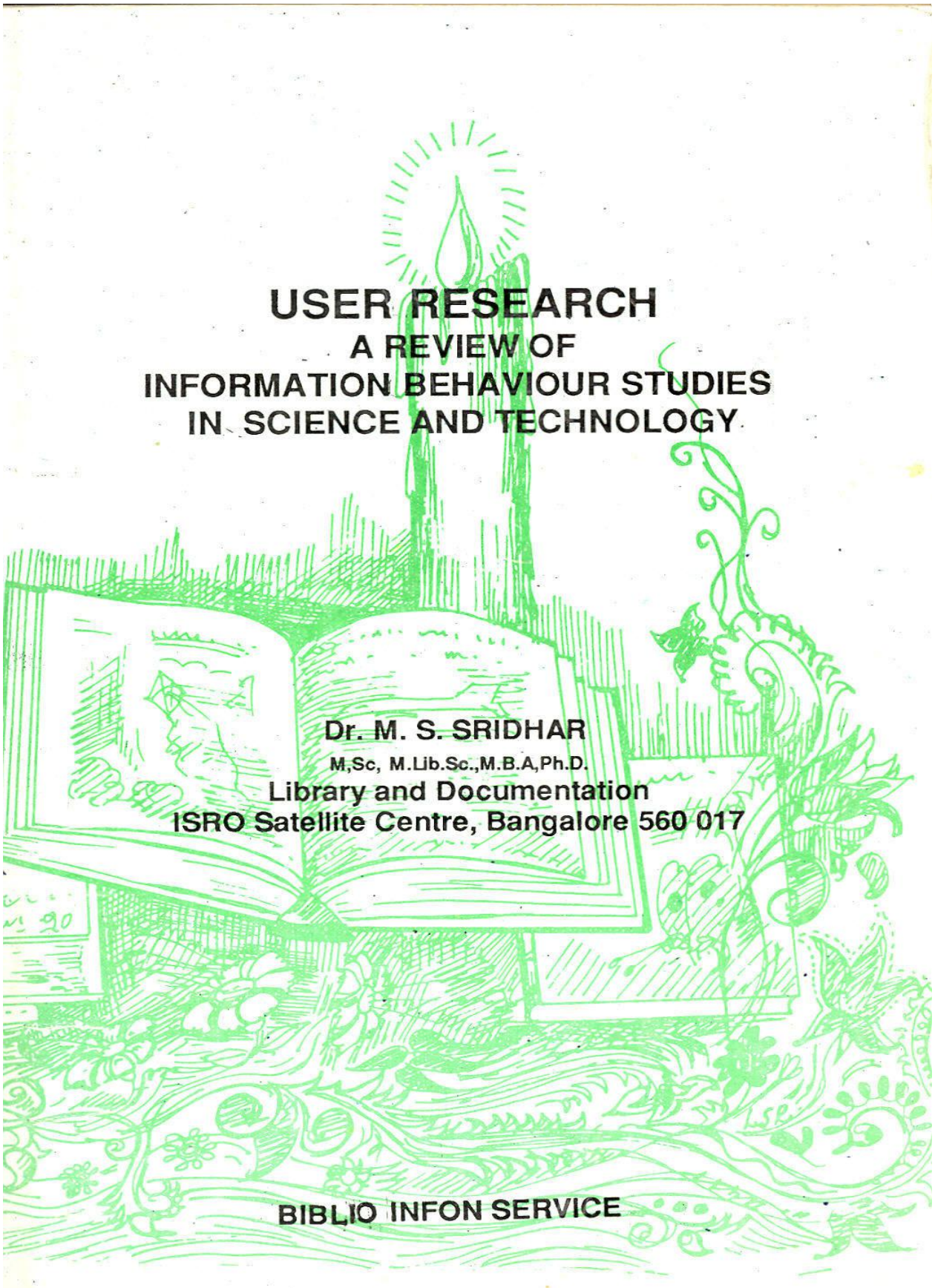


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ABOUT THE BOOK : A handbook for researchers, practitioners, managers, teachers and students of library and information science as well as those in the area of science, scientific communication, sociology of science, scientometrics; covers user, use information behaviour, communication behaviour, information transfer, scientific communication, knowledge dissemination and utilisation, information requirement, need and related studies; Brings together and presents in juxtaposition the widely dispersed works and their findings; Compares and consolidates work done in the area. Indicates gaps that exist and evaluates the results.

"It has been an excellent information analysis and consolidation of research work of three decades of information users and their characteristics. Experience of a specialist librarian is visible in presentation of text. It also presents an inkling into research problems to be pursued for precision in prediction and analysis" says Dr. M.A.Gopinath.



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PREFACE

It was a pleasant surprise on a recent sunday afternoon, when my friend Shri. M.S.Sridhar called on me and handed over his document on User Research. He shyly asked me to go through it and if I find it good, I should give a preface. I undertook to read it.

As I opened the text for reading, I felt the depth of search and interpretation in the subject area of Information User Studies. It is no doubt that no information is worth having unless it has use. Use of information is wide and varied. It may be to gain new knowledge, may be understanding already known one, or it even be stimulating new ideas or triggering a research project and confirming the already known ideas.

Users of information have behavioural and other constraints. Information seeking behaviour is an important aspect of the study. The psychological nuances in identifying the information need, the ways of browsing for information, methods of discriminating relevant with nonrelevant information from a diverse lot of information sources and media, accessing the information store with ease, and the methods of absorption and assimilation of information and also the methods of disseminating information in different mileu. In general, we have to understand the process of articulation of information from its generation, processing and diffusion.

Every User of Information is a different person. He is different in different context. It becomes role-specific. He is different when he is thinking, or talking, or writing, or learning. Modes of handling a situation varies from the varied background from the familial to educational types. Thus user studies are necessarily specific to the contexts. The modelling of such results into generic patterns is an ardous process but inevitable. The design and development of information storage and retrieval systems needs inputs from such modelling of results of information user research. It has to be theoretical reduction as well as pragmatic assimilation. Such modelling can be time-dependent, space-dependent, event-dependent, and object-dependent.

Shri. Sridhar has taken efforts to do such an effort in the text of this document. He has covered a wide array of instances of user studies clime-wise and time-wise. It has been a professionalised review of user studies. It is densely western in gathering and but oriented to developmental problems of countries like India.

It has been an excellent information analysis and consolidation of research work of three decades of information users and their characteristics. Experience of a specialist librarian is visible in presentation of text. It also presents an inkling into the research problems to be pursued for precision in predication and analysis.

I have great pleasure in recommending you to open the pages of the text for reading and knowledge.

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Bangalore
07.07.1987

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PREAMBLE

Some time ago when I was doing my MBA, I realised that observing people has always been an interesting and rewarding experience. But when I mentally compared the place of customers in business with users in libraries, I felt that librarians (atleast in India) have given lip sympathy to the user component of the system. The danger, more so in libraries, is in treating books as animate beings and the library users as inanimate things. Routine activities in libraries give least scope for considering each user as an unique and complex personality. Libraries try to label each user as a person belonging to a predetermined group and expect him to exhibit a particular approach towards information and libraries. As a result librarians have been, quite often, baffled by the totally unexpected and unique ways of information-seeking by their clientele. Many a times, the unpredictable approaches of users have thrown standard theories and techniques of librarianship into disarray.

When I gathered literature on user-research for choosing a problem for Ph.D. thesis, I was partly amazed at the enormous work done at macro level especially by non-librarians abroad and partly disappointed to see nothing worthwhile reported from India. Though much ado exists about user studies in the profession, user-research is the most neglected aspect of librarianship especially in third world countries. One striking feature noted is that even the available literature is scattered across many disciplines and there is no single comprehensive review which brings together findings of atleast major user studies of last four decades. User-research has been carried out at different levels and with different perspectives under different names such as information behaviour studies, communication behaviour studies, information transfer studies, scientific communication, scientometrics, science of science, sociology of science, knowledge dessemination and utilisation studies, information requirement/need studies, etc. Having scanned several thousand references and read about 2000 documents on this multidisciplinary area, I could not resist writing a review of the work done in this area for last four decades.

Information industry lacks rigorous customer behaviour studies and market research. Some piecemeal studies have attempted for limited inquiry with particular discipline in mind. The information behaviour of scientists and engineers have been looked from different angles by librarians, sociologists, psychologists, communication specialists, managers and others. Bringing together, the widely dispersed works and their findings in the form of an authentic and comprehensive review for the benefit of all concerned in this multidisciplinary area was felt necessary. Though the same objects have been inquired with similar objectives by different specialists in different names, their findings have not been brought into juxtapositoin to compare and consolidate the work done, to show the gaps that exist and evaluate the results for cumulative growth.

Bangalore
6th February 1987 **M.S.SRIDHAR**

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I wish to record my gratitude to Dr. H.A. Khan, Professor, Department of Library and Information Science, University of Mysore, Mysore for going through the manuscript in greater detail and suggesting some changes. I am grateful to Prof. U.R. Rao, Secretary, Space Commission and Chairman, Indian Space Research Organisation (ISRO)and other seniors and colleagues of ISRO Satellite Centre (ISAC) for their inspiration, encouragement, guidance and help for all my professional activities.

In preparing this review, I have drawn literature support from many institutions, libraries and individuals. Institutions like Aslib (particularly Mr. Blaise Cronin), CRUS (particularly Mr. Brain Clifford), Denver Research Institute, University of Denver (Mr. Jody Briles), CRUSK, BLR & DD, ICR (Stanford University), BASR (Columbia University), Office of Management Studies of Association of Research Li-braries, and individuals like Prof. William D. Garvey (The John Hopkins University), Dr. R.I. Raitt of European Space Agency (ESA), Mr. M. Wise and Mr. N. Ghosal (College of Librarianship, Wales), Mr. Alice C Crippen (Indiana University),Mr. Donald Case (Graduate School of Library & Information Science, University of California) and many others have readily spared references and literature about many research works and projects in the area. I sincerely thank all them and the authorities of the concerned institutions.

I have heavily depended on the libraries of DRTC and NAL, both at Bangalore, for literature. In addition, literature support was received from the libraries of ISRO Satellite Centre (ISAC, Bangalore), University of Mysore, Bangalore University, Vikram Sarabhai Space Centre (VSSC, Trivandrum), Space Application Centre (SAC, Ahmedabad), Social Science Documentation Centre (SSDC, New Delhi), Indian National Scientific Documentation Centre (INSDOC, New Delhi), Administrative Staff College of India (ASCI, Hyderabad), British Library (Bangalore), BLLD (UK) and many other libraries. I am indebted to the authorities of all these libraries.

I record my sincere thanks to Dr. M.A. Gopinath for having agreed to write a preface to the book.

Bangalore
6th February 1987 **M.S.SRIDHAR**

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SELECTED LIST OF SYMBOLS, ABBREVIATIONS AND ACRONYMS USED

AAES	**American Association of Engineering Societies**
ACSP	**Advisory Council of Scientific Policy**
ADI	**American Documentation Institute**
AERE	**Atomic Energy Research Establishment (U.K.)**
AFIT	**Air Force Institute of Technology**
AFSC	**Air Fouce Speciality Code**
AGARD	**Advisory Group for Aeronautical Research and Development (NATO)**
AIAA	**American Institute of Aeronautics and Astronautice**
AIP	**American Institute of Physics**
APA	**American Psychological Association**
ARIST	**Annual Review of Information Science and Technology**
ASIS	**American Society for Information Science**
ASLIB	**Association of Special Libraries and Information Bureau**
BASR	**Bureau of Applied Social Research (Colombia University)**
BLLD	**British Library Lending Division**
BLR & DD	**British Library Research & Development Division**
CBRI	**Central Building Research Institute**
CRC	**Centre for Research on Communications (of JUH)**
CRS	**Congressional Research Service**
CRUS	**Centre for Research on User Studies (University of shiffield)**
CRUSK	**Centre for Research on Utilization of Scientific Knowledge**
D & U	**Dissemination and Utilization**
DDC	**Defence Documentation Centre (U.S.A.)**
DOE	**Department of Energy (U.S.A.)**
EJC	**Engineering Joint Council (U.S.A.)**
ERIC	**Educational Research Information Centre (U.S.A.)**
ESA	**European Space Agency**
GSFC	**Goddard Space Flight Centre (NASA)**
HIP	**High Information Potential**
IASLIC	**Indian Association of Special Livraries & Information Centre**
ICR	**Institute for Communication Research (Stanford University)**
IEE	**Institution of Electrical Engineers (U.K.)**
IEEE	**Institute of Electrical & Electronics Engineers (U.S.A.)**
IEG	**Information Exchance Group (NIH Project)**
IME	**Institution of Mechanical Engineers**
INFROSS	**Information Requirements of the Social Sciences**
ISB	**Information seeking Behaviour**
ISR	**Institute for Social Research (University o fMichigan)**
JHU	**Johns Hopkins University**
LC	**Library of Congress (U.S.A.)**
LIP	**Low Information Potential**
MEDLARS	**Medical Literature Analysis and Retrieval System**
MILUS	**Military standards (U.S.A.)**
MIT	**Massachusetts Institute of Technology**
NASA	**National Aeronautics and Space Administration**
NIH	**National Institute of Health**
NISP	**National Information System for Psychology (APA Project)**
NISPA	**National Information System for Physics and Astronomy (AIP Project)**
NISSAT	**National Information System for Science and Technology (India)**
NLL	**National Lending Library (Later BLLD)**
NSF	**National Science Foundation**
NTIS	**National Technical Information Service**
ORG	**Operations Research Group (Case Institute of Technology)**
PIE	**Physics Information Exchange (AIP Project)**
RAC	**Reliability Analysis Centre**
RAE	**Royal Aeronautical Estabilishment (U.K.)**
RAM	**Random Alarm Mechanism**

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RDT & E	**Research, Development, Test and Evaluation**
SDR	**Solution Development Record**
SIE	**Scientific Information Exchange (APA Project)**
SIRED	**Survey of Information Requirements ofEngineering Designers (U.K., Ministry of Technology)**
STI	**Scienctific and Technica Information**
TEA	**Lasers Transversely Excited Atmospheric Pressure CO_2 Lasers**
WFEO	**Worls Federation of Engineering Organisations**

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CHAPTER 1

INTRODUCTION

Information is an amorphous concept, less susceptible to a precise definition. Yet, everyone has to deal with it in many ways throughout one's life. "Indeed, information has been described as the fifth need of man ranking after air, water, food and shelter" (Kemp, 1976, p101). Information- collection, transfer and use are all - pervasive and universal activities in all walks of life. It was conservatively estimated in 1972 in USA "... that R & D organisations invest 1.25 million dollars in a 30-year career of a scientist or engineer" (Vincent and Mirakhor,1972,p45) and "...upto 90% of the work involved in any white-collar job involves the seeking and obtaining of information" (Evans, 1976, p266). This enables one to see that an enormous amount of money is indirectly being spent on information-related activities of any work. A study of U.S. industries in 1967 revealed that the cost of acquiring information from outside-the-firm (excluding overhead) ranged from $ 2170 to $ 7550 per professional employee per annum (Gilmore et.al., 1967, p113). Thus, knowingly or unknowingly, intentionally or unintentionally, all of us most of the time of our life and work (including the actions of the author and the reader at this moment) are concerned with information - its generation, recording, processing, repackaging, transfer, receiving, use and application. In the words of Debons (1974, pxiii), "information enfolds man physically and spiritually. It is the vehicle and substance ... [and] ... is a resource ... for ... power ...".

Knowledge[1] in general and information in particular become more meaningful when they are transferred and communicated. The concepts `information' and `communication' are so coexistent that they are often used synonymously without much distinction in common usage and one often implies the other in many situations. In the context of scientific communication, Garvey (1979, p2) while emphasising the fact that communication is the essence of science says, "... communicability becomes a salient feature of a scientific product...". Further, information is very closely related to communication. A discussion of the one brings to the fore, the other. The information `explodes' into power only when it is transferred and communicated. In other words, information is activised by communication.

Information and communication are equally important in the efficient and effective management of any enterprise. They have definite relations with performance of R & D organisations and industries as well. Based on a series of empirical studies Rothwell and Robertson (1975, p393) concluded that there exists "...a positive relationship between good and efficient communication and successful industrial innovation". Weinberg (1967) emphasises the same in a slightly different way when he says "...though it is true that poor management can and does occur with the best of communication systems, poor communication almost always leads to bad management".

The purpose of transfer and communication of information is `use'. Without the intention on the part of the ultimate receiver or beneficiary of information to use it, the whole excercise of transfer and communication becomes futile and information transferred becomes redundant. On the other hand, seeking and communicating information are two sides of the same coin from the viewpoint of individuals concerned. Both have the same purpose:use. Information which has no use is no information. Thus the central thread of the whole range of activities relating to information- transfer and communication is `use'. Hence the emphasis on `use' and user-orientation to communication and information - whether from a formally designed and operated information-system or from an informal source. A wide range of research works centered around `use' and user of information called `use and user-studies' have cropped up in the last four decades.

Footnote

[1] Compared to information, knowledge is believed to be passive and an item of knowledge becomes an item of information only when it undergoes the active process of communication.

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CHAPTER 2

NEED FOR USER-RESEARCH

The user is the key person in any information- system. All the luxuries of information-revolution and problems of information-explosion are centered round the user and his convenience. Understanding the user is half the battle in providing information-services. The success of any information-system depends considerably on how best the system design is based on a close and accurate understanding of the users. The user is not only the most important aspect, but is also, paradoxically, a dynamic component of information-system. As such, understanding `user' is an important and a continuous activity. `Know thy customer' is the cardinal rule of any business enterprise. Accordingly, extensive market research, customer-behaviour studies and demand forecasting are carried out in business. A formal information centre or library is yet to pick up these activities in the same spirit. It may be partly due to not-for-profit and paternalistic nature of information- systems and partly due to practical difficulties connected with the factors such as uniqueness of information-services, dual role of information as raw material as well as product or service, dual role of customer as producer and consumer of information, the competing and complimentary informal system of communication. Infact, information-system is not concerned with just demand, it has to stretch its hands to know the information-needs, the motives and purposes of seeking information, ways and means of gathering information and the entire user-attitudes and practices in relation to information.

There appears to be a lopsided emphasis in library and information field on user-education than on understanding the user. This is largely due to the systems designed and implemented, which are unfriendly, complex and not concerned with the perceived needs of users. What is more important is intensive librarian-education about users than mere education of users of the existing system (Thompson, 1982, p11). Hoadley and Clark (1972, p133) say that a library can achieve its goal "... if the library is more precise about who its users are. This precision, coupled with more research into behaviour and information-gathering patterns of these user groups, will assist the library more effectively in developing programs and using its resources and limited funds to achieve desired goals." Accurate and up-to-date knowledge about users and their information-behaviour is one of the essential ingredients for designing an information-system. The need is for user-driven design than technology-driven design and more research on human variables of information-system than technology and system variables (Atherton, 1975, p672). Unfortunately, the emphasis in the profession has been on imparting technical skills than information skills.

The effectiveness of library and information-system depends on the extent to which the system-characteristics correspond with the user and on how much the potential user is willing and able to make use of it. Kunz and others (1977, p9) say "A sufficient identification, analysis and co- ordination of the `real' information-needs of the user is an essential basis for the planning, implementation and operation of information-systems and networks." In addition to "this `objective aspect', the `subjective aspect' of information-system - i.e., in the eyes of [the user] ... is unjustly neglected. Disregarded is the fact that a particular class of people will accept modes of information-transfer only if they are applicable to their habits, their style of work, etc., and only if certain minimum practical requirements are met".

System designers, planners and managers have, by and large, failed to properly consider the role of human factors and their effect on acceptance and utilisation of information (Mick, 1980, p21). Oldman (1976, p1) reviewing the research in librarianship says "A particular style of systems analysis has dominated library management research both in this country [U.K.] and in the United States in the last decade. The starting point for this research has been the library system. A more important starting point is the target for information - the individuals who constitute the `receiving' community." "It is well reconginised that the user has been given inadequate consideration from almost any point of view in most information - supplying systems existing today ...". Landau and others (1975, p422) further say "... in a great majority of

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cases, the user is neither understood nor studied nor, in some cases, even identified until after the system is already evolved or in a completely operational state. Some have characterized this as an `upside-down system design."[1]

Research in library and information science is more meaningful if the findings increase the efficiency and effectiveness of information flow. To do this the emphasis should shift from system or service-oriented research to user-oriented research. Like in business, efforts should be put in primarily to relate product or system design to the perceived needs of those for whom the product or system is intended and the system operation should be guided by the knowledge about the user (Cronin, 1981, p37). Finally, selling or promoting the information-services and user-education should only take a secondary position subject to the condition that the system design is based on a proper understanding of the user. In this way only a librarian can improve upon his role as an information-transfer agent. He has to intimately and individually understand the requirements of his users and continuously update his knowledge about users through systematic studies and observations.

There is another very interesting line of argument from Garvey about why librarians should actively involve themselves in user-related research, communication and information-transfer process. Himself a scientist, Garvey (1979, p5) analyses the role of librarians and pleads "the sooner librarians can interact with scientists in this process [of communication] the better they can fulfil their information-service functions." His argument is that "a real scientist cannot become sole `information man' unless he sacrifices his research productivity" (p10) and "since it is not likely that the typical scientist is going to become an expert in librarianship, then the librarian must become expert in the communication structure of the world of science" (P16). In the words of Foskett (1984, p61) "it is not enough for librarians merely to respond to new ways of recording and disseminating information. A more creative approach will come from a much greater involvement with both producers and consumers of information.

User-studies are necessary not only for planning and designing information systems but also for their efficient and effective operation. "A systematic and comparative study often reveals unanticipated data, which may prompt hitherto unconsidered courses of action" (Rowley and Turner, 1978, p56). There will be many surprises to even an experienced librarian about his own clientele as he would not have heard them all in a systematically planned setup in his day-to-day work. The obvious drawback in relying on experience is bias towards outspoken and intensive users, which is, at times, either too pleasant or too bitter. Incidentally, user-studies would help to improve the relation of the library with users in an objective way provided it is done within the organisation concerned.

More user-studies are needed not just to dertermine and confirm the general patterns of information-gathering, but to identify departures from the norm which, even if only in small areas, have significant practical effects (Hanson, 1974). For various reasons, the literature on user-research has necessarily been voluminous. Yet, findings are disproportionately smaller. Ignoring extensive data, repetitive as well as fragmented presentations, the literature does not appear to be so voluminous. The behaviour-related research in information- storage and retrieval is not great - either absolutely or relatively. Very little is known about user's preferences which can be used with confidence in the design of a new information-retrieval system. Due to its contingency nature very few studies can be considered to be relevant for a given user-population.

Markee (1972, p119) stresses the need for user- research in the parent organisation and says that "a review of the library literature reveals that the amount of library research being done by the librarian at his institution is not in proportion to his professional responsibilities." He answers the question as to where the research should originate by saying that the "library research should begin and continue right in the parent institution." This bottom-upward approach can only provide a solid foundation for national information systems of developed and developing countries.

Eventhough considerable research has been done in the area of user-studies in developed and information rich countries, especially U.S.A., Britain, Western and Eastern European countries, practically nothing substantial is done in less developed countries in general and

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India in particular. Not even a single major user-study in any of the areas of science and technology has been done in the country. Even the major national information system designs were not preceded by systematic, reliable and comprehensive user-studies. As such many present systems are surviving under `symmetry of ignorance' (Kunz et. al., 1977, p67-68), mathematical induction of convenient good or bad things, subjective considerations and idiosyncracies of people involved in planning information systems. Other systems are thriving under dubious reasons of avoiding the duplication of research and resultant economic benefit arising out of information systems but the hidden apparent reasons of an information system, as Myers (1970, p26) says, could be treating information system as prestige centre or a form of fringe benefit to employees or a paid up insurance to serve an unanticipated need or to sublimate the feeling that one does not read or a centralised way of budgetary control over expenditure on documents.

Footnote

[1] Brittain (1975, p429) says a lip service has been paid to this objective in many user-studies.

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CHAPTER 3

SCOPE, STRUCTURE AND BACKGROUND OF THE REVIEW

The studies named variedly as `user-studies', `information-need studies', `use-studies', `information-transfer studies', `communication-behaviour studies', `Information-behaviour studies', `dissemination and utilisation studies' are closely related, and often not precisely defined. Menzel (1966, p43) tries to delineate these studies and says "when approached from the point of view of the scientist or technologist, these are studies of scientists' communication-behaviour. When approached from the point of view of any communication medium, they are use studies. When approached from the point of view of the science communication system, they are studies in the flow of information among scientists and technologists." Hence the terminology depends much on the approach and the angle from which one sees. To give a specific focus to the present review a simple linear approach to various information-related and information- seeking activities of users is assumed (on line with models of human communication and motivation theories). As per this assumption some motives and purposes of users give rise to information needs and requirements. To satisfy such needs and requirements users adopt many ways and means of accessing and searching sources of information. Then they try to acquire necessary information both regularly and in an adhoc way as necessary from these sources. In the act of acquiring information, the user uses or calls upon the sources of information and applies the information to the purposes as predetermined, thus leading to satisfaction or dissatisfaction in relation to purposes and needs. In reality these sequentially represented steps are neither discernible nor strictly linear. Though information- seeking behaviour in one sense deals with actual seeking of information represented at the stage of means of searching various sources of information, it would be more appropriate to cover other earlier stages and later stages to get a clear picture of the entire sequence. However, more emphasis is placed on initial phases.

It is extremely difficult to review the entire user-research done so far. Many significant contributions have been made by psychologists, sociologists, behavioural scientists and others in addition to library and information science personnel. As a result, the literature is scattered across many disciplines and varied collections have to be scanned for location of literature. Further, there is a very wide variation in the scope of user-studies. These studies touch upon many peripheral areas such as bibliometric studies, use-studies and citation studies. There is no consistency in the use of terms and concepts in user-research. Loose and interchangeable use of terms have made it difficult to compare findings of various studies. As a result, user-research is continuing without much consolidation. Above all, the biggest hurdle for review of even well- defined user-research relating to science and technology is the abundant number of studies and publications. Consequently, in this review highly selected, but important, studies and their findings have been considered and cited[1]. After a quick quantitative and geographical look at the past user-research, a chronological bird's-eye-view of important-milestones spread over nearly four decades is presented in this chapter. The subsequent chapters deal with the status of user-research in India, theoretical background and framework of user-research, broad findings of information-behaviour of users in relation to various user-characteristics and finally, the findings of significant studies on specific aspects of information-seeking behaviour (ISB).

Though it is very difficult to make an accurate estimate of the total number of user-studies/bibliographic items of literature on user-research there are several estimates made by experts. Kunz and others (1977, p10) have estimated more than 2000 bibliographic items as of 1977, Crawford (1978,p61) found some 1000 papers in 1979 and Stibic in 1980 (1980,p17) estimated that there are about 1000 papers dealing with the problems of information needs and habits. The growth rate is estimated as some 30 studies a year. Krikelas (1983, P 5) says "simply from the point of view of mass, user-studies probably form the largest single body of research literature in librarianship". User-studies in science and technology alone are

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considered numerous. Depending on the definition of user study, while the estimate of Line (1968,p10) varied between 400 and 600 studies, Brittain's (1970,p13) estimate varied from 400 to 800. Distrust of previous findings and the conviction that scientists in a particular environment are unique in their ISB are two reasons for so many user studies (Paisley, 1965). Many of these studies are largely repetitive without much cumulation of knowledge about users and a single study often leads to multiple bibliographic items with varying degrees of duplication of data and information. User- studies are basically behavioural and social research oriented studies essentially involving extensive data and descriptive literature and their scope is very vast. Hence, depending on purpose, scope and quality criteria of the reviewer, estimates of the number of user-studies have varied widely[1].

Geographically and historically, U.S.A. has taken a lead in empirical user-research followed by U.K. and other European countries (Kunz et. al., 1977,p10). Studies on information needs and uses were rigorous in U.S.A. during 1960s, but the early 1970s also saw a remarkable array of concerted efforts in other nations, particularly U.K., Canada, The Netherlands., Russia and East Germany to study the information needs and uses of scientists and technologists (Lin and Garvey, 1972 ,p5). One can call 1960s and 1970s respectively as the renaissance of user-studies in U.S.A. and U.K. Other countries in general, the developing and under-developed countries in particular, do not have much to claim even today in this area of research (Lipetz, 1970; Crane,1971).

Footnotes

[1] Difficulties of summarising such studies of 1960s was expressed long back by Parker and Paisley (1970, p87).

[2] US Federal Council for Science and Technology (1965) has found that only 58 out of 450 studies identified were based on objective data

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CHAPTER 4

A CHRONOLOGICAL BIRD'S-EYE-VIEW OF THE LITERARURE

It can not be confidently said that the same degree of concern about users has existed ever since users and libraries existed. There has been a slow evolution of positive attitudes on the part of library-managers shedding restrictive practices such as chained books and closed-access systems. But restrictive practices such as borrowing limitations, user-un-friendliness, membership barriers, punitive fine system, etc. continue to exist even today in different degrees. As such, concern about users and a systematic research about their problems is rather a twentieth century development, and more particularly during the last 40 years.

4.1 1940s

The history of user-studies is often traced from the Royal Society Scientific Information Conference of 1948, wherein are reported two studies focusing mainly on the serial literature by Bernal and Urqhart[1]. Bernal (1948), a psychologist by profession,surveyed the use of journals by British scientists and Urqhart (1948) surveyed users of the London Science Museum Library to determine their source of references, purpose of seeking information and resultant satisfaction. These are considered the first significant user-studies and the papers presented by the authors became the `founding papers.'[2] These two studies together with studies like that of Fussler (1949) on the use of literature by physicists and chemists, a survey by Scates and Yeomans (1950) about relative dependence upon different means of keeping up with current research by 1661 working scientists and engineers drawn from three different environments constituted the important user-studies of the 1940s. Interestingly, the study of science of science itself began around the same time in the late 1940s (Scott, 1959,p110-114).

4.2 1950s

Research on users started in the late 40s, gained momentum during the late 50s and mushroomed during the 60s and 70s. Hanson reported that since Bernal's study "...at least three dozen other investigations have been reported (till 1964) of the needs of scientists and engineers for information, of their information-gathering habits, and use to which they put information" (Hanson, 1964,p64). Naturally a majority of these studies belong to the 50s[1]. Hintz's (1952) trans-national comparative study of botanists from U.S.A., U.K., France and Germany and a study about communication in team research by Hertz and Rubenstein (1953) are two worth mentioning studies of the early 50s. Herner (1954, 1958) through personal interviews of scientists of Johns Hopkins University (JHU) found differences in information-gathering habits of scientists in different disciplines and institutions, and also tried to classify/analyse reference queries to determine information requirements in the field of atomic energy. Shaw (1971 and n.d.)in his study has requested 105 research scientists of US Forest Service to describe the nature and purpose of all reading-acts over two months and surprisingly found the questionnaire-method superior to the diary-method of investigation. The Social Survey of U.K. conducted two pilot studies of a general nature (Willcoock,1953). The first in the year 1952 covered industrial establishments employing more than 10 persons in two towns and the second in the year 1953 which covered 132 medium sized establishments (having 50-900 employees) in the light engineering industry in Birmingham. In continuation of these studies another study (Scott, 1959, 1960; Thomas, 1954; Clader, 1959) in two parts was conducted during February-April 1956 which covered almost half of the electrical and electronics industrial establishments of U K with a size of 200-1000 employees. The study interestingly, included managers and all technical grades from foreman upwards, and defined them as technologists.

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Totally 1082 individuals from 127 establishments were interviewed for about an hour each to collect data about user-characteristics, information-sources used and information-behaviour and attitudes.

Like the Royal Society Conference of 1948, during the 1950s the International Conference on Scientific Information (1958) has brought many important studies like that of Glass and Norwood (1959) on ways of discovering relevant references by scientists, Hogg and Smith (1959) on communication of R & D personnel of U.K. Atomic Energy Authority, Scott (1959) on use of technical literature by industrial technologists (based on the studies of The Social Survey mentioned earlier), and Fishenden (1959) again on discovering (nearly 1900) useful `units of information' by atomic energy (AE&RE) scientists by diary card method[1]. The conference also saw results of studies of Halbert and Ackoff (1959) on dissemination of scientific information based on 25,000 direct observations of the daily activities of 1500 U S chemists and Menzel (1959) on planned and unplanned scientific communication based on his studies at the Bureau of Applied Social Research (BASR) of Columbia University.

Towards the end of the decade, Voigt (1959) interviewed 200 Danish scientists and science reference librarians in the fields of biology, chemistry and physics to explore ways of discovering relevant information and to relate approaches to information with the purposes for which it is sought. Menzel (Columbia University, 1958) in his exploratory qualitative pilot study at BASR interviewed 69 respondents (20 biochemists, 28 chemists and 21 zoologists) of an unidentified prominent American University about their information-exchange activities. He probed into information needs, unsatisfied needs, means and occasions of information-exchange, the characteristics of a scientist which influenced his needs, sources of information used, etc. and contributed significantly towards a theoretical framework for later research. Menzel (Columbia University, 1960) also made a first ever comprehensive review of literature on the flow of information among scientists (for NSF) in January 1960 and continued his work at BASR during 1960s.

Maizell (1957,1958,1960) examined relation between creativity (as measured by publications, patents and judgment of superiors) and information-gathering and using patterns of 94 industrial research chemists based on questionnaire and diary[2]. Operations Research Group (ORG) of the Case Institute of Technology[2] (1960) extending from an earlier study of chemists done in early 1957 under contract to NSF, conducted a reading-behaviour survey of 297 chemists and 404 physicists from 55 industrial, 13 academic and 3 government organisations. The data was collected by questioning executives as far as characteristics of organisations are concerned, through a small questionnaire for personal characteristics of the scientists and a Random Alarm Mechanism (RAM) where respondents after an introductory session recorded their reading acts as per a predetermined schedule by self-observations on an average of 3-5 times each day over 14 days. Totally 735 reading observations were made and some interesting conclusions drawn.

The study by Egan and Henkle (1956) about ways and means of use of information by research workers and Thorne's (1954) survey of reading habits of scientific and technical staff at the Royal Aeronautical Establishment (RAE) are the other two worth citing studies of the decade.

4.3 1960s:

The period of 60s and 70s witnessed a very large number of user-studies. Evaluative presentation of all these studies is beyond the scope of this work. However, an attempt to present some of the significant studies is being made here. Areas within user-research like informal and inter-personal sources of information and unplanned or accidental acquisition of information were untouched during the 40s, partially touched during the 50s and fully explored during the 60s. A very interesting feature of the 60s is that user-research became the concern of institutions. Many experimental projects and empirical studies were sponsored, supported and even undertaken by organisations on a continuing basis during this period. In addition, many reviews of user-studies including the noteworthy document Annual Review of Information Science and

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Technology (ARIST) by American Documentation Institute (ADI, later American Society for Information Science - ASIS) with a chapter on `Information Needs and Uses'[2] were produced.

4.3.1 User-Studies of U.S.A.

In 1961 the American Psychological Association (APA) began a large scale intensive and comprehensive study of information-exchange behaviour of scientists within a given scientific environment. A highly significant work has been done by Garvey, Griffith and others in this field which enabled APA to bring out over 20 reports (Garvey and Griffith, 1964). The communication-behaviour studies or studies of the flow of scientific information or dissemination studies from the point of view of the scientist as disseminator were virtually unknown till then (Menzel, 1966). Though APA's work is extensive in communication studies and user-behaviour studies, most of them also appear to be sociological rather than psychological as psychological dimensions were not found in these studies. Garvey, Griffith and others later at Centre for Research on Communications (CRC) of JHU, carried out a series of longitudinal studies and developed a large database on the communication-behaviour of scientists. Considering `conference' as the focal point and using questionnaire and interview techniques, this team attempted to find out from the participants, the inception of research ideas, the flow patterns of information in research findings till the time the latter were published. "The weakest aspect of the Hopkins studies is the failure to utilize a sufficient number of background variables to allow comparisons between different types of respondents" (Crane, 1971, p 18).

Allen and his associates (1966 ,1977) at Alfred P.Sloan School of Management of the Massachusetts Institute of Technology (MIT) carried out a series of tightly-designed information-transfer studies with innovative techniques like Solution Development Record (SDR)[1] and identified technological gatekeepers[2]. They had access to the confidential evaluation (contract) reports of NASA on two or more teams having contract for identical projects.

Unlike the APA (which had NISP and SIE projects), the American Institute of Physics (AIP) with its limited background research on information-transfer processes, launched NISPA and PIE Projects again with the financial support of NSF (Libby and Zaltman, 1967). It faced bitter criticism in the columns of Nature, Physics Today and Physical Review for having assumed the role of an information-switching centre for informal distribution of pre-prints among physicists. On the other hand, the National Institute of Health (NIH) in U.S.A. formed and operated seven similar Information-Exchange Groups (IEGs) as part of a project and concluded that the concept-formalised system for informal communication (i.e., pre-print exchange service) is workable (Thorpe, 1967). But a post-experimental questionnaire survey revealed that "any evidence that the IEG accelerated scientific discovery is at the most fragmentary" (Heenan and Weeks, 1971, p 38). The most ambitious user-surveys of the decade are the twin large-scale studies of the US Department of Defense (DoD) carried out by the Auerbach Corporation (1965) and the North American Aviation (1966). Auerbach conducted two-hour long depth interviews with as large a sample as 1375 persons comprising scientists, engineers and technicians drawn from a heterogeneous multi-disciplinary population of 36,000 research, development, test and evaluation (RDT&E) personnel doing varieties of tasks belonging to several organisations within the US Army, Navy, Airforce and other defence agencies. The extensive design and the tested methodology, which laid emphasis not only on critical incident-technique but on information rather than media which carried information, has been highly acclaimed (Berul and Karson, 1965; Sieber, 1964).

During the second half of the 1960s, Parker and Paisley at the Institute for Communication Research (ICR) of Stanford University studied information exchange at conventions (on line with APA), analysed 500 sample citations, carried out two mailed questionnaire surveys of the information processing behaviour of communication researchers.

The Center for Research on Utilisation of Scientific Knowledge (CRUSK) established in 1964 at the Institute for Social Research (ISR), the University of Michigan under the stewardship of Havelock with members like Mann, Pelz, Andrews, Lingwood, Nelson and others carried out a series of studies on generation, dissemination and utilisation of scientific knowledge. It

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emphasised on maximising use of scientific knowledge and a better understanding of how knowledge is transferred from research to practice. CRUSK has not only conducted empirical studies, but has also consolidated on a number of empirical research studies from related areas of sociology and scientific communication and tried to evolve conceptual framework (Havelock, 1973). Pelz and Andrews (1976) in their questionnaire survey of 1311 scientists and engineers (from 11 heterogeneous types of laboratories, 7 departments of Midwestern University and 5 government laboratories) examined relationship between the performance of scientists and the organisational environment which included freedom/autonomy, communication with colleagues, diversity of tasks, dedication, motivation, job satisfaction, similarity to colleagues, creativity, age, co-ordination and groups. Pelz (1964, 1967) further analysed the data for assessing the R&D climate which is conducive to technical accomplishments and creativity and for testing earlier findings about creative years (age) of scientists and engineers.

Havelock and others (1974) have carried out a comparative study of six U.S.Federal R&D information systems, namely, DDC, NASA, NTIS, MEDLARS, CRS (Congressional Research Service) of LC and ERIC. Lingwood and Mc Anany (1971) conducted a mailed questionnaire survey of members of the Brazilian Chemical Association with 24% response to test some hypotheses generated by a model for information flow in developing countries. One of the observations made was that "the means for gathering needed information are similar all over the world, but styles differ according to local conditions "(p 16).

Davis (1965) surveyed 300 US engineers by personal interviews and another 1500 through questionnaire (40% response) for their use of various written sources of information and compared the results with chemical engineers within his response sample and among different functional groups (i.e., nature of work). Major conclusions included the need for educating engineers on the available information materials, a very high use of manufacturers' catalogues and handbooks by engineers.

Lufkin and Miller (1966) in a questionnaire survey of 2,200 (80% response) engineers of the American aerospace and avionics industry explored the extent to which professional engineers attempted to continue their education by reading journals and internal technical reports. Gilmore and others (1967) in their study of channel of technology acquisition in 73 American organisations from four industries through interviews and through self administered questionnaires (48% response - 480 respondents) focused on how technical information outside-the-organisation has originated and obtained. Goodman (1967) at Douglas Aircraft Company conducted what is claimed to be a very large and comprehensive survey of 1500 scientists and engineers drawn from a population of 1,20,000 scientists, engineers, and technical personnel employed in 73 companies, 8 research institutes, and 2 universities to determine the S&T information flow process.

Rosenberg (1966, 1967) requested through a mailed questionnaire a sample of 175 persons (52 from research and 44 from non-research organisations responded) to rate eight information-gathering methods on a seven-point scale according to `ease of use' and amount of information expected. He concluded that research and non-research professional personnel in an industry or government do not differ to any appreciable extent in their evaluation of information-gathering methods, and the preference for a given method reflects the estimated `ease of use' of the method rather than the amount of information expected.

Rosenbloom and Wolek (1967) using the critical-incident approach examined the information-transfer process by surveying 2000 scientists and engineers in 13 establishments of 4 large American Corporations and 1200 members of Institute for Electrical and Electronics Engineers (IEEE) through self-administered questionnaire. In a series of studies since 1963, they explored the process of acquiring information, the means by which information flows among technical groups, and, association of characteristics of information-transfer process, and the means by which information-transfer takes place. Nearly 2000 recent instances of acquiring information useful to the work from a source outside the immediate circle of colleagues, were collected and analysed against various characteristics of users.

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Perrucci and Rothman (1969) in a study of 3200 graduate engineers found that Ph.D.'s differ considerably from non-Ph.D.'s in their self-estimated knowledge of science and engineering subjects that they had studied in college, and in their awareness of the emerging new fields in science and technology. Rubenstein has led a series of research on management of R&D at Northwestern University during 1960s (initiated in 1959) under ten distinct but related projects. Two of them, namely `idea flow in R&D' and `the information-seeking behaviour of researchers' are relevant to user-studies. Rubenstein initially probed into `information-seeking styles' and tried to categorise researchers into relatively distinct types with respect to their information-related behaviour (1966). Some of the significant studies in this series are that of Trueswell and others (1965) about x-ray crystallographers, Werner (1965) about ISB of medical researchers, Moor (1969) about relationship between personality traits of R&D personnel and dimensions of information systems and sources. Rubenstein (1970) himself, with others, carried out a segment of Project Hindsight and studied the ways in which engineers seek specific information, and in the process claimed to have developed procedures for observing their behaviour.

4.3.2 User Studies of U.K.

Aims (1965) along with Flower (Great Britain Advisory Council On Scientific Policy) during 1963-64 surveyed 6194 U.K. physicists and chemists (1:2) with 3021 usable responses and found a general similarity of the information-seeking and using habits of chemists and physicists and even the scientists in R&D did not show a significant difference from the group as a whole.

Martyn (1964) made a questionnaire survey of 647 industrial, academic and government research scientists (with as low a response as 22.3%) about how they get themselves familiarised with the background literature for their current research projects. In addition to information-seeking habits, the survey yielded data about their failures to find essential information.

Wood and Hamilton (1967; Wood, 1969) in a questionnaire survey of 5000 mechanical engineers (54% response) tried to relate respondents' age, nature of work/activity, type of industry and place of employment to three types of information requirements propounded by Voigt (exhaustive information, everyday information and information on subjects other than mechanical engineering), use of publications in general and journals in particular. Comparing the results of their study with his own study, Davis (1965) concluded that use of literature by American engineers is remarkably similar to that of British engineers and, typically, the American engineers hardly looked into British journals, and British engineers into American journals.

A joint study by Slater from Aslib (on behalf of IEE) and Keenan from AIP of current awareness methods of physicists in both U.S.A. and U.K. soon after publishing Current Papers in Physics found no really significant difference between the requirements of the physics community in the two countries, (Keenan and Slater, 1968, p 106) physicists were interested in keeping up-to-date in their own specialisation than in the field of physics as a whole and realised the advantages of speedy acquisition of information (Slater and Keenan,, 1967, p 2) by a good current awareness service.

4.3.3 User-Studies Outside U.S.A. and U.K.

Though not much is reported from other countries during the 1960s about user-research, Kotani's study (1962) of communication among Japanese scientists through a questionnaire survey of 400 authors of 20 leading journals is quite interesting. As expected, there was a heavy dependence of Japanese scientists on scientific information produced in U.S.A. and the choice of research topics in physics, chemistry, electrical engineering and biochemistry were naturally influenced by American information, geology, geography, botany, zoology and physiology by Japanese sources. Interestingly, Japanese scientists made a significant use of U.K. sources for physics, German sources for chemistry and French sources for mathematics.

4.4 1970s

4.4.1 User Studies of U.S.A.

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User-research in U.S.A. continued during the 1970s but at a much lesser pace. Wolek (1972),by interviewing 30 experienced technologists of three US companies, found a rich period of preparatory activity preceding the inter-personal communication. Holland (1970, 1972) surveyed three different organisations to determine information-use habits and how colleagues are valued as a source of information. He found `high information potential' persons in each of the organisations. Chen (1974) made a survey of communication practices of academic physicists with 179 usable questionnaires representing 53% response. She studied the channels of communication (sources of information), and use of Library. Hall (1972, 1973) has carried out an interesting quasi-controlled experiment to study the personal effectiveness of R&D scientists and engineers of two unidentified major American Corporations at three sites (one of them is aerospace corporation) and has tried to relate a number of personal habits to measure of work-performance. Out of a population of 491 (385 were aerospace oriented) scientists and engineers, he chose 25 `top performers' as per peer rating, 37 `discussion stars' (i.e., those considered to be the most popular partners for discussion of technical subjects) and a control group of 85 persons from the residual study population (one was both `top performer' and a `discussion star'). He found that the information habits of `top performers' were not significantly different from those of the control group except that they were more likely to attend professional society meetings. The `discussion stars' had a greater diversity of technical interests, but were not found to have more than the average number of `technical discussion' partners from outside their laboratory and hence they were not found to perform any function of the two-step flow (i.e., technological gatekeeper). Hall could not develop a well-designed statistical sample, and most of his respondents were primarily engaged in developmental work. He suggested that comparison of performance with technical communication should not be tried for a diverse group.

The two other studies worth mentioning are: (1) a series of studies (Bunch et.al., 1978; Almeido and Harvey, 1979) in continuation of a 1962 study (Allen, et. al, 1962) about the US Air Force maintenance technicians' attitude towards the technical data and their use for maintenance of weapon system, and (2) the survey made by Herner and others (1979) relating to Goddard Space Flight Centre (GSFC, NASA) Library.

4.4.2 User-Studies of U.K.

During the 1970s user-research flourished in U.K. Many studies have been directly sponsored or indirectly supported by the British Library Research & Development Division (BLR & DD), in addition to those conducted for and by Aslib and other agencies. Aslib conference at the University of Bath has brought many papers related to user-research (Line, 1974). The Centre for Research on User-studies (CRUS) was established in 1975 at the University of Sheffield (and aided) by BLR & DD with the purpose of promoting awareness of the value of understanding information-users' needs and behaviour as well as understanding information-seeking and using behaviour[1]. This can be considered to be a major event of this decade. The user-research in U.K. has spread to cover even social sciences during this period. In addition, many organisations and individual researchers of 1960s discussed so far also continued their work and published many findings.

Surprisingly, Wood and Ronayne (1972) found that much of the journal-reading by chemists (of Royal Institute of Chemistry and the Chemical Society) is for recreational or habit motives or is a mechanism for maintaining a sense of social contact with other scientists i.e., for finding material, for conversational and social among one's fellow professionals and 16% of Nature's readers in the sample gave `situations vacant' as their main purpose in looking at that journal. Rothwell and others (1974) in project SAPPHO studied 86 innovations (43 successful and 43 unsuccessful) in chemical process and scientific instrument industries. They found no correlation between the source of idea and either success or failure of the innovation.

Some results of a survey of information-requirements of engineering designers (SIRED) commissioned by the U.K. Ministry of Technology in 1969, were reported by R.M.S. Hall (1969). Sutton (1976) has compared these results with that of Wood and Hamilton (1967) about mechanical engineers and Advisory Council on Scientific Policy (ACSP) about information needs of physicists and chemists (Aims, 1965).

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Under contract to BLR & DD, Bitz and others (1975) at Manchester Business School have carried out a broad and comparative study of communication patterns in high energy physics, geology, cancer research and clinical bio-medical research. A very significant work of the 1970s about information-needs of engineers is that of Gralewska-Vickery (1975, 1976) again funded by BLR & DD. This macroscopic study covered 120 respondents from organisations within as well as outside U.K. (the actual usable questionnaires were 400). By using multiple methods like questionnaire, interview, visit-to-organisations, study of correspondences and diary, analysis of citations and evaluation of two abstracts, she has attempted to determine the information-needs and habits of earth science engineers and relate the same to environmental, organisational, work-related, and personality characteristics of respondents. In another BLR & DD supported Project, Ritchie (1977) has demonstrated, using data collected through questionnaire, that minimum path methods can be used to determine the consequences of organisational change in an R&D laboratory on interpersonal communication network.

Johnston and Gibbons (1975) with the aim of determining the patterns of information-flow for a successful innovation analysed the characteristics of information contributing to the solution of technical problems of 30 randomly selected on-going innovations in British industry. By adopting face-to-face focused interview with the personnel directly concerned with the technical development, they dwelled into the sources of information used, the relation between information-source and content and the relative importance of each unit of information to the problem-solving process. Lastly, Robertson and Rothwell (1974, 1975) also studied information-needs and information-seeking behaviour of scientists and engineers in U.K. R&D laboratories.

4.4.3 User-Studies Outside U.S.A. and U.K.

There has been a considerable increase in user-studies outside U.S.A.and U.K. during 1970s and 80s. A meeting of AGARD (1976) has brought together papers and presentations of many countries. Bethell (1972) conducted a study using single type as well as repetitive type questionnaires, very similar to that of Allen, in an international laboratory covering 55 researchers of twelve nationalities (with an educational level of at least M.Sc.) to test hypothesis relating to informal communication patterns, `communication stars', `technological gatekeepers' and `isolates'. As part of plans for national information networks in Norway , the Norwegian Centre for Informatics surveyed 1400 professional engineers and university graduates with the objective of mapping and quantifying the use of different information-sources, and users' opinion on these sources. One of the significant findings in contrast to findings of earlier studies was that written or documentary sources played a dominant role in relation to the personal sources (the ratio being 70:30) (Disch,1976).

A study of information-behaviour and needs of engineering students of Chalmers University of Technology in Sweden (Fjallbrant, 1976) information-gathering behaviour study of technical experts in Hungary (Buza, 1971), a study of information-needs of innovators in manufacturing companies in U.S.S.R. (Mal'tseva, 1979) and a theoretical paper on information needs of Pakistani scientists and technologists (Mohajir, 1977) are some of the studies of the decades done outside U.S.A. and U.K.[1].

4.5. 1980s

A few relevant and significant studies made during the first half of the 1980s including those for which announcements are made or interim or final results are published are presented here.

Shuchman (1980, 1981, 1982) of the Futures Group Inc. has made a mailed questionnaire survey of 3371 sample engineers from 89 of the 2700 firms (1315 responses received - 39%) with the objectives of (i) producing a profile of the information used by engineers (ii) identifying the methods of communication and patterns of use by subject, job activity, industry, education, degree, date and age, (iii) identifying the attitude towards and use patterns of information technologies. Unfortunately, not only the criteria for selection of sample firms and sample engineers were not clear, but also the representativeness and adequacy of the sample could not be fully judged due to limited analysis of the characteristics of the population, sample and response sample. In addition, no rigorous statistical tests have been employed in the analysis.

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The study of Summers and others (1983) relating to ISB of educators is quite interesting and useful from the view-point of methodology and techniques. One of the observations of this study is that " ... personal, professional and psychological attributes play varying roles in predicting source use. Attitude appears to play a major role as do position and information dissemination habits" (p 85).

Raitt (1984, 1985) studied through a questionnaire, the patterns of information-usage of diverse groups of scientists and engineers in three international organisations and three large aerospace R&D laboratories. This survey met with an abnormally low response both at the organisation-level as well as the individual-respondent level. Out of 14 organisations invited for participation, only six agreed and out of 1107 questionnaires distributed to individuals, only 287 (25.93%) returned the filled questionnaire. The total population from which the sample of 1107 is drawn appears to be of the order of more than 6000. Further, the sampling technique followed is not made clear and the response-sample characteristics have not been fully analysed and compared with the characteristics of the sample.

Sridhar (1987) using multiple and complimentary investigation methods (`weekly summary of information related activities', questionnaire, interview, observation, analysis of records, semi-controlled experiments, and other indirect methods) has carried out a broad baseline (almost census) study of information-seeking behaviour of the Indian space technologists of a single organisation and tried to relate various aspects of information-seeking behaviour to their characteristics like status, experience, nature of work, qualifications, specialisation and professional activities and achievements.

On line with the concern expressed at Aslib conference (Line , 1974; Grose, 1974) about the information malnutrition of under-privileged and deprived users and non-users of libraries, Slater (1984) at Aslib designed and carried out an ambitious and unusual study (again sponsored by BLR & DD) about non-use of library-information services in industrial-commercial concerns by chemists, structural engineers and insurance company staff. He considered a respondent who did not use a library at his work-place as non-user and classified non-users as voluntary and involuntary (the former is one who is not using `a staffed library-information service' which existed at the work-place, and the latter being a non-user as there was no service existed to use). Slater points out an imbalance in the ratio of user to non-user research and had the objective of exploring the reasons for the non-use and sub-optimal usage of library-information units at the work-place. The most unfortunate aspect of this questionnaire survey was the terribly poor response of about 15%, ostensibly for the lack of interest in the subject and the fear of exposure among the respondents.

Another interesting recent study is a survey of 1666 researchers, practitioners and policy makers through questionnaire and a sociometric analysis of inter-personal communication-network by Salasin and Cedar (1985).

Other recently-done user-studies are : Kremer's (1982) study of information needs and habits of engineers in an US design company (in Brazil); a study of information-needs of scientific leadership in Germany (Afanasiev and Prilyuk, 1982); a study of information needs of scientists at the U.S.S.R. Academy of Sciences (Bolshoi and others 1982); Fedotova's (1981) study of information requirement at different stages in the production cycle (U.S.S.R.); Barreto's (1982) study of Brazilian chemists, and Selvarani's (1983) study of information needs of engineers in Singapore.

Many researchers who had already undertaken user-studies earlier have also continued their work during the 1980s. For example Wolek (1984) examined how managers in nine engineering firms encouraged their professional engineers to acquire and make use of scientific and technical information and found that use of S&T information did not enter strongly into reward system. Following Wolek's study, Orpen (1985) studied the relationship between company performance and the different ways of managers encouraging their scientific and technical staff to use S&T information. He surveyed through questionnaire 272 scientific and technical personnel from R&D departments of 25 electronics and instrumentation firms to conclude "...that

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organisational performance is positively associated with the extent to which managers encourage employees in their R&D departments to make extensive use of STI" (p308).

Lastly, the ongoing research on the information needs of mechanical engineers by Michael Neale and Associates Ltd. sponsored by BLR & DD appears to be another significant study of the present times.

Footnotes

[1] Kunz et.al.(1977,p10) without mentioning the names claim that first studies about users date back to 1920.

[2] Brittain (1971,p5) objects to calling these two papers as `founding papers' as there were library surveys earlier dealing with particular aspects of library system. In this sense it is extremely difficult to pin point when exactly user studies began.

[3] Studies relating to scientific productivity like that of Melzer, Pelz, Andrews and others are kept outside the scope of this review.

[4] Voigt (1959), while ranking the sources of reference information found all the four studies agreeing remarkably on relative importance of the sources of reference-information.

[5] The diary method did not prove fully satisfactory in this study.

[6] The paper of Halbert and Ackoff (1959) at the International Conference on Scientific Information mentioned earlier is based on studies at the Case Institute of Technology.

[7] Though ARIST reviews are quite useful they tend to be somewhat selective and reflect the interest and slant of reviewers (Wood, 1971, p 11).

[8] SDR is a variation of the diary technique, wherein respondents report periodically the progress made in solving a specific problem and the information used.

[9] Wilkin (1981, p 4.43-4.44) expresses a doubt on the findings of Allen and his associates that engineers make less or scarce use of literature, as use of literature in their study confined to books and journals, and the sample studied included applied researchers and not practicing engineers.

[10] The CRUS continued since the beginning of 1985 as Consultancy and Research Unit, Department of Information Studies of the University of Sheffield after BLR & DD's initial grant-in-aid expired (Roberts, 1985, p3).

[11] During the 1970s many significant contributions to user-research in terms of reviews, theoretical frameworks, comparison of earlier findings, use-studies, specific aspects like `invisible college' and `technological gatekeeper' phenomena and information behaviour of social scientists, educationists, medical scientists, etc. have been made by Line, Crane, Lancaster, Vickery, Brittain, Ford, Skelton, Ward, Totterdell, Barber, Kent, Fishenden, Wilson and others.

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CHAPTER 5

A REVIEW OF SELECTED INDIAN USER-STUDIES

(Status of User-Research in India)

At this stage, before proceeding with the findings of important information-behaviour studies in the science and technology area, it is necessary to mention here the Indian contribution to user-research. It has to be stated regretfully that, so far, no single comprehensive user-study has been reported in the country relating to scientific/technological institutions. Many piecemeal research works of varying qualities have possibly been done and only some of them have been published. Even with a liberal yardstick about the soundness of methodologies adopted, comprehensive and adequate samples studied and rigorous analysis of the data made, one cannot find enough empirical studies covering many types of users and many aspects of information-behaviour. One striking feature of the Indian literature on user-research is that there are a large number of so- called theoretical and review types of papers repeatedly stressing the need for user-studies, quoting the findings of the studies of either USA or UK, suggesting further research in the area and, unfortunately, without any data or observations of their own. An equally good number of other studies appear to be of an ephemeral nature and of peripheral interest to user-research. Another feature is that there is an over-emphasis on bibliometric studies in general and citation studies in particular. But the utility of such studies in understanding the users is limited. Besides, there are a number of master's degree theses, submitted to various library schools, of highly limited scope and utility (obviously due to limitations of resources, expertise and time). But only a few of such studies are known outside the library schools concerned.

In the last five years, hardly 4.69% of the published articles dealt with user-studies (Amba and Raghavan, 1985, P 133) and among the ongoing doctoral research just one study each is on communication and use/user-study (Kumar, 1983). A large majority of over 25 papers published so far in the Library Science with a slant to Documentation under information-user-studies series as well as those published elsewhere under similar names do not directly deal with information-behaviour aspects. A recent special issue of ILA Bulletin (v.22,n.3-4,October 1986 - March 1987) on users' approach to information which carried nine papers on the topic is not an exception.

It is not unexpected that Ranganathan (1970) gave a framework and foundation for user-behaviour studies in India when he discussed the psychology and the nature of work of users. Among the theoretical and review-type publications, Gopinath (1984) gave a bird's-eye-view of latest trends in information-sources, information-transfer and communication as well as a review of significant studies of information-seeking behaviour. He has also analysed the nature of work of product design engineers and the process of product design (presumably a mass produced consumer product) to identify the decision-making situations leading to a need for a particular type of information-services in industry (Gopinath, 1980). Here the need for product-related information is discussed from the angle of maker of the product rather than the user of the product. Rajagopalan and Rajan (1984) presenting an account of programmes and activities on user-studies in India with emphasis on success and shortfalls, try to deduce, from the five laws of library science propounded by Ranganathan, a conceptual framework for user- and use-studies. This paper is supposed to be a stock taking of Indian user-studies, user-education programmes and use-promotion studies. The authors claim that there exists a fairly good body of literature reporting user-studies at the level of individual libraries (p4). However no single major or minor user-study has been cited in support of it. Hence it is difficult to judge on the scope and nature of the studies they hint at. In a recent review of information-requirements and information-gathering habits of scientists, Satyanarayana (1985) draws heavily from the findings of studies done elsewhere to categorise users in general, assess their information needs, sources and use of information and attempts to draw his own conclusions. Gupta (1981) reviews literature about type, sources and channels of information used in three stages of technology-

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transfer, namely, idea-generation, problem-solving and implementation and diffusion. Krishan Kumar (1982) stresses the need for user-studies and development of expertise within the country and also presents a program for determining information-needs of health science users. Saha (1970) presents yet another theoretical paper quoting observations and findings of stalwarts like Bernal and Line without any data or conclusion of his own. He stresses the need for the development of a sound methodology and research into factors determining information-use pattern and categorisation of users. Unfortunately he goes on to make guess-type observations such as "...the user-studies in a mission-oriented library and information service are much less complex as the user population is less divergent in nature and relatively known" (p5) which is far from the truth. Ironically, the second IASLIC seminar (1965) during September-October 1962 dealt with `users and library and information service', but not even a single paper presented in the seminar carried any hard survey data worth comparing with the user-studies of that time in USA and UK.

As regards studies reported with some statistical data, way back in 1964 the Scientific Information Bureau (N.P. Rao, 1966) of Defence Science Laboratory, Delhi made a too simple a pilot-survey about information activities in 21 R&D laboratories/establishments of the Ministry of Defence. Though the survey produced simple data about available information facilities, publishing pattern and broad communication activities, this is probably the first and one of the very few attempts of user surveys at the national level by a government agency. Rao (p4) found in this survey that the optimum size of an R&D laboratory for maximum production of papers is 250 persons and laboratories other than equipment intensive laboratories showed greater output in terms of research papers.

Pruthi and Nagpaul (1978, 1979) investigated the communication patterns in two research projects (with 40 and 5 persons) of a national laboratory through profiles, two sets of questionnaires and structured interviews with a longitudinal approach to examine the relationship of communication- patterns to individual's status, educational level and social relations, to identify technological gatekeepers, to study the role of formal and informal communication in problem-solving and idea-generation. Though the study is on a specific aspect of communication with limited sample, this work of non-librarians received attention of reviewers apparently due to better design of the study.

B.N.Singh (1981) in his analysis of 1971 citations from articles and comments appearing in two engineering-oriented Indian journals coupled with a questionnaire survey of 55 research engineers and engineering faculty (with 42 responses) at three technology institutes tried to assess the information-needs of engineering scientists in India. The limited sample as confessed by the author and the limitations of citation analysis cause aspersions on the reliability of the results.

A study of information-seeking behaviour of space technologists mentioned earlier was a broad based (yet focused) study with innovative variety of techniques and extensive hard data (Sridhar, 1987).

Srinivasan (1970) stressed the need for more economical methods of user studies in developing countries and advocated indirect studies such as citation studies, analysis of records of user requests, interlibrary loan and other observations ignoring the fact that reliability of research findings cannot be fully sacrificed for economic considerations. Srinivasan himself restricts to reporting elementary statistics of citations (not even percentages are worked out), translations, inter-library loan requests of scientists of Central Building Research Institute (CBRI), Roorkee. Even a seminar on "the role of the libraries in communication process and information flow" (S.N.Singh, 1980) saw hardly any primary data under its themes of `communication', `information flow' and `the librarian/information scientist as a communicator'. All the presentations were of theoretical and casual nature with no specific orientation to communication and information-flow process. A few other studies which carried some statistical data are that of Nagarajan (1970) on information needs of technocrats in industries, Krishan Kumar (1968) about teachers and research scholars of the Department of Chemistry of the University of Delhi, Bhavani (1982) on publishing pattern of 125 physicists and chemists and Kanaka Rekha (1984) on communication-behaviour of Indian food technologists.

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Interestingly, it is the academicians and students of library and information science who have conducted some surveys and gathered hard field data. In addition to Bhavani (1982) and Kanaka Rekha (1984) cited above, Kailash Chandra Garg and Ashok Kumar (1984) surveyed 150 scientists for their information-gathering habits in three unspecified R&D laboratories of Delhi through questionnaire with 50% response. Not only was the sample inadequate, (physics, chemistry and mathematics were represented by 46, 11 and 18 respondents respectively), but also the response-sample characteristics were not analysed.

Again, pointing out the nonavailability of comprehensive user-studies and the studies relating to information needs of users in India, S.N.Singh (1979) reviewed the project works of four of his M.Lib.Sc. students at Banaras Hindu University mainly based on citation analysis, observation, questionnaire and interview techniques and concluded that no single method is foolproof. In fact, however poor they may be (obviously due to the limitations under which they are carried out), it is only the students of library and information science who have gathered some field data within the limited resources and time. Unfortunately, a large chunk of them go unnoticed as they are neither fully bibliographically-controlled nor the findings of a majority of them are published.

The above presentation is only a representative of the type of user-research carried out in the country as far as science and technology information-users are concerned. The review clearly indicates the void in nature of user-research in the country. User-studies have been neglected both at local and national level by planners of S&T information systems. The piecemeal studies have been mostly local studies of a particular aspect of user-behaviour. The majority of even the piecemeal studies are done by academicians and students. Unless sufficient baseline studies are done within the country by the information personnel `living with the tribe', further developments cannot be carried out based only on the findings of studies done in USA or UK.

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CHAPTER 6

CONCEPTUAL FRAMEWORK AND THEORETICAL BACKGROUND FOR USER-RESEARCH

One of the widely accepted conceptual frameworks for user-research is that suggested by Paisley (1968). He places the information-user at the centre of ten systems namely cultural system, political system, membership group, reference group, `invisible college', formal organisation, work team, one's head/mind, legal and economic system and a formal information system each forming concentric circles around the user. Except one's own head or mind, all other systems are external to the individual and they form his environment. However, one should not forget the complex interactions involving one's own head/mind in terms of personal attitudes and accumulated experience with one's present role, function, task and all other environmental systems. It is these complex interactions which lead to individual information-behaviour. This conceptual framework, however, is in congruence with the functionalist theory/view of scientific growth propounded by Merton (1957) especially the fact that science exists as a subsystem within a larger social system. Yet, some hold the view that scientists live in two worlds, scientific world and a separate `outside' world (Garvey, 1979, p 3). From this it appears that each one of the systems proposed by Paisely are not only task-dependent and situational, but also exert influence on the user to a varying degree.

The factors/variables which affect information-transfer process and user-behaviour are innumerable and any empirical study has to make its own assumptions to simplify the situation (Oldman, 1976,p 34). Otherwise, one would be lost in the jungle[1]. A model of information-seeking activities of scientist and his research group presented by Orr (1970) provides a fairly exhaustive list of factors that affect the scientist's ISB. He asserts that any particular type of communication-behaviour must be assessed in relation to all other communication-behaviours.

In the past, there was no agreement about the scope of ISB as well as user-studies. `Seeking' is used interchangeably with `gathering' and `using' information. The terms `communication-behaviour' and `information-transfer/flow' are used almost synonymously with ISB. However, a thin line of demarcation can be drawn. ISB studies confine to the point of view of user as receiver of message or information. The communication behaviour studies primarily emphasise user as producer and/or sender of message or information. Hence as a person communicating information, user plays the role of source of information or a creator of a source of information. Hence, the user often plays multiple roles such as receiver, creator and sender of message in communication-behaviour studies. The third broadly related area is the information transfer/flow studies where the whole process is looked at from a systemic view without much slant to either receiver or sender of information. Wersig (1970, 1973) as well as Wersig and Windel (1981) discussed the systematisation of user-research and divides it into four areas emphasising user as channel for communication, as information receiver, as data sources and as information sender. Thus user assumes the role of a channel and a source too. Kunz and others (1977, p 66) also identify how the distinction between `users' and `sources' of information is vanishing and both become `partners' participating in the networks of knowledge generation and transfer.

In the process of seeking information what mainly takes place is an effort to match a cognititve need of user with a source of information and seeking supply of information to satisfy the need. This process naturally involves many phases and factors. First, the need could be unclear and uncertain. Secondly, user could be biased, subjective, conservative, habituated and having his own styles and idiosyncrasies[1]. Further, apathy towards a new service or system[2] is not unusual and in one case researchers were reluctant towards new services (even though they desired) and did not even directly examine the service attributing it to lack of time (Trueswell et.al., 1965; Vancott and Kincade, 1967).

Havelock and others (1969, p 4.10) observe that "...individuals who are consistently exposed to innovations which fail or innovations which produce only minimal success may develop a general resistance to the acceptance of innovations". It appears like an inverse of `success breeds success theory' and `Matthew effect'. They conclude "...that individuals are just not very simple; they continue to elude the social scientists' attempts to place them in neat categories which would

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provide the base for clear theoretical statements" (p 4.11). As such, the individual's initiative plays an important role to recognise a need for information, to seek and search information and to use it irrespective of availability of services (Wilkin, 1981, p 4.30). However, this does not underestimate the importance of availability of information facility/service for one to seek and use. In fact, availability or existence of needed information is one of the necessary conditions, next only to the need and the initiative to use. Then comes the sufficient conditions that the available facility/service should not only be accessible to the user but also easy to use. Above all, the user should perceive that the source or facility is useful for the need concerned. The perceived utility of a source is based on both the quantity and quality of information expected from it. Ignorance about a piece of useful information either due to the apathy of the user or due to failures of information system when realised leads to alter the composition of monitor, reserve and supply of information in a cost efficient way to yield a relatively satisfactory information supply provided the ignorance is neither too small to worry about nor too large to be remediable (Wilson, 1977, p 74). In the process of adaptation of altered system the cost in terms of time and efforts is optimised and sources that adapt to needs of user are preferred to sources which require the user to adapt himself. In other words, personal information-gathering is often purposive, adaptive, habitual and economical (Wilson, 1977, p 80). The lack of awareness on the part of the user about existing information-systems could also be a factor for its non-use in addition to convenience, responsiveness and ability to conduct dialogue with the system (Ackoff et.al., 1976, p 143).

Atherton (1977, p 7) summarises these factors involved in seeking and using information in the following words. "The working habits of the individual needing information, the importance placed on getting it, the facilities available for seeking it, the knowledge about the facilities, the judgment of their value, the estimate of the probability of getting what is wanted - all of these factors may affect information-seeking behaviour. Unless a person who wants information is fairly sure of getting it without much trouble, he is apt to do without it if it is not essential. Relying on memory, skirting around the issue or making do with incomplete or vague information from a colleague are not unusual behaviour traits. There is, however, a small group of users who actively seek information spending effort and resources to acquire pertinent information and these users in fact are the most progressive in economic activity". Scientists and engineers are more likely to invest or reinvest efforts and resources for reinventing than to derive it from the research or development work of someone else, especially someone they don't know, in a different organisation and in a different discipline. (Havelock et.al., 1969, p 8-16). They may even estimate that generation of new knowledge will be cheaper than an expensive and possibly fruitless search (Paisley, 1968, p19- 20).

The complex trio concepts, viz., accessibility, `ease of use' and perceived utility of a channel are extensively investigated by Allen and Gerstberger (1967, 1968). The concept `ease of use' which is akin to `law of least efforts', Mooer's law1 and `why bother theory of information usage' (Cooper, 1978) appears to be the supreme criterion in use of a source of information (Rosenberg, 1966, p19). Moor (1972) has developed a model incorporating seven dimensions as measurable components of the concept `ease of use' of an information system. The dimensions are - movement required (out of the user's personal work area), time delay, interaction, interface structure, required location of use, permanence (nature of information provided) and response filter. The model was empirically tested from the data from R&D personnel and concluded that these dimensions do serve as a model for identifying behaviour.

Footnotes

[1] Two of the assumptions made recently in Oxford study of pre-clinical and clinical staff of National Health Service of U.K. are interesting (Brember, 1985, p 66).

[2] In the context of formalisation of informal communication such as `invisible college' and `gatekeeper' functions , Cronin observes that "scientists display a remarkable conservation in their information seeking practices" (1982, p 228) as echoed in the experimental projects of APA, AIP and NIH.

[3] In an interesting account Barber (1961) presented the general resistance of scientists for innovation itself and pointed out elements within science which limit the norm and practice of open-mindedness.

[4] Users will utilise an information-service only when doing so costs them less than not using it (Mooers, 1960, p(ii)).

CHAPTER 7

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CORRELATION OF USER-CHARACTERISTICS WITH INFORMATION-SEEKING BEHAVIOUR

Many user-studies have looked for similarities and differences among the users in terms of their backgrounds like status, age, experience, education, specialisation, field of research, discipline, etc. When the analysis is at the organisation level (as against individual level) they looked for difference in nature of organisations, and at the same time users were also grouped as theoreticians or fundamental research workers, experimentalists or applied re-search workers, technologists, technicians, practitioners,etc.

7.1 Organisation as Unit of Analysis

Most of the studies have adopted the individual as the unit of analysis. However, occasionally analyses have been carried out at group, unit or organisation levels treating the organisation as a composite entity and drawing typical representatives. At this level, variations within the organisation are ignored and the nature, type and size of the organisation become variables. A typical example of it can be found in the finding of the Social Survey that the "use made of technical information by establishment, and the number of channels of technical communication available to it increased markedly with size of the firm, up-to a level of 100 employees. However, there was evidence [which Scott's inquiry also supported] that somewhere not far beyond this level further increase of establishment ceases to have any further effect" (Willcock, 1953). A similar correlational attempt in an Indian study (N.P.Rao, 1966, p4) revealed that the optimum size of R&D laboratory for maximum production of papers is 250 persons and equipment intensive laboratories tend to produce less research papers than others. Yet Halperin and Chakraboti (1987, p173-174) found linear inverse relation between size of the firm and productivity in papers and patents.

Hanson (1964) found that industrial and government personnel differ from those in academic institutions in their information-behaviour in many ways and the organisational differences were more pronounced than the differences in their disciplines. Wolek (1984), based on 18 incidents of managers routing information to their subordinates and encouraging subordinates consciously to use scientific and technical information originating outside-the- organisation, hypothesised that among the factors contributing to high performance is the use of S&T information. Orpen (1985), following Wolek's study found that the performance of the firm (based on sales growth and return on assets) is positively associated with the extent to which managers of its R&D units encourage employees to make extensive use of S&T information.

Bernal (1959) found the fundamental researcher making the greatest use of information but not as varied as applied researchers and technologists. Gaston (1970, 1973) using a sample of U.K. high energy physicists found that the information-seeking practices of experimentalists and theore-ticians were quite different. These differences in information-seeking practices of different professionals are mainly attributable to the basic differences in their nature of work.

Extensive studies[1] on the information-behaviour of the scientist versus engineer/technologist have repeatedly shown and confirmed that scientist is `papyrocentric'[2], predominantly literature-dependent, `cosmopolite'[3], fairly autonomous and engineer/technologist is `papyrophobic'[2], predominantly oral and informal communication-oriented, `localite'3 with group allegiance and mostly compelled to choose projects. Marquis and Allen (1966) found that scientists know each other in the research front beyond the organisational-and national boundaries and likely to form `invisible colleges', and hence, have more communication with external groups. On the other hand, technologists work in close association with co-workers, likely to have greater internal communication and look upon `technological gatekeepers' within the organisation for information. Rosenbloom and Wolek (1967) also found that engineers drew most of their information from in-house sources (63%) and scientists looked outside for most of their information (67%).

7.2 The Individual as the Unit of Analysis

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In information-behaviour studies with the individual as the unit of analysis, it is possible, and easy, to list many characteristics of individuals for a correlational study. Unless the relevance and the context of a user-characteristic are clearly established, it is likely that the results will be conflicting. "To attempt to isolate each environmental element seems hopeless, but awareness of the variety of environments may lead to potentially useful hypotheses " (Krikelas, 1983, p11). The number of systems to which each user belongs and the variety of roles he has to play are important in understanding the information-transfer process. Many earlier studies have confirmed the significance of identification of population segments and examination of ISB against user-characterisitcs. Yet,the following limitation needs to be noted: "The large number of uncontrolled variables and the differences in population make it impossible to draw hard and fast conclusions as to precise effects of individual activities ..." (Ford, 1977, p16).

7.2.1 Correlations with Demographic-Characteristics

Age and experience of users are often correlated to their information-behaviour. Though the differences among men and women in their choices and success in education and mass-communication are explored in the respective disciplines, information and communication-behaviour of men and women are not compared and systematically studied. Educationists have found that girls under-achieve than boys in science and more markedly in physical sciences than biological sciences. The reasons for such a difference could be social, cultural, educational, biological or psychological. Science is not simply male-dominated, but that it is in some sense `masculine'in that men are numerically predominant, and personality traits, characteristics of successful scientists are those which are stereotypically male. In U.K.,a lack of awareness among secondary school girls about a possible career-choice of engineering, difficulty faced by girls in getting admission to engineering courses and certain biases and shortcomings in the system were noticed by educationists (Kelly, 1981, p92, 139-149). On the other hand, research findings in mass communication suggest that "... there are consistent differences between men and women in their information-processing habits. Women seem to ingest, store and reproduce information with less distortion than do men" (Bauer, 1973, p146). Though both Shuchman (1980,1981) and Raitt (1984) have speculated that women engineers had a disadvantage in accessing informal communication in a predominantly man's world of aerospace engineering, the differences in information-behaviour between men and women were not analysed. Sridhar (1987) found no significant differences between men and women space technologists in time spent in information-gathering, including the relative time spent and dependence on formal and informal sources of information, intra-organisational communication, use of bibliographic references, degree of delegation of information-gathering work and use of library documents. However, women tended to have fewer inter-organisational contacts, more consultations with colleagues for references and more interactions with the primary library than men. Almeida and Harvey (1979) made a secondary analysis of data from an earlier survey (Bunch, et.al.,1978) of 546 maintenance technicians of Air Force Institute of Technology (AFIT) to see whether six demographic variables AFSC (Air Force Speciality Code), skill level, pay grade, amount of maintenance experience, amount of supervisory experience and weapon system have any significant impact upon their attitudes towards technical data. Four specific aspects of technical orders examined were adequacy and the level of writing, purpose of use and frequency of use. It was concluded that the technicians' perceptions of both the adequacy and the level of writing of their technical data differed significantly by AFSC. Additionally, it was found that the technical orders differed significantly by AFSC, skill level, pay grade and weapon system. Finally it was found that the technicians' perceptions of the frequency of usage of their technical data were significantly different for all six demographic variables tested. Scates and Yeomans (1950), in their study of scientists and engineers found that generally there is no variation of information-behaviour with age but suggested a fall in most types of activities beyond the age of 30.

Experience generally builds up the attitude of resistance to change. Havelock and others (1969, p4.9) quotes Newcomb and others "... that the greater the amount of information an individual has about a particular topic the more difficulty there will be in changing his attitude in that area". It is also found that more experienced users generally use more informal techniques for gathering current and retrospective information than the less experienced (Menzel, 1970).

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7.2.2 Correlations With Personality-Characteristics

The personality-characteristics have not yet been fully explored and no true psychological investigations of user-behaviour are attempted except one or two (e.g.,Moor,1969,1972). However some characteristics like performance, productivity, creativity, motivation, emotional stability, temperaments, interests, personal idiosyncrasies have been hypothesised occasionally with information-behaviour. It also appears that more attention has been paid to performance and productivity-characteristics than others.

The wide variety of ways adopted in measuring the success, performance, productivity and creativity of scientists and engineers could be classified into two types. First, a `subjective measure' based on judgment of oneself or peers/coworkers, supervisors or a panel of experts or management team against given attributes like contribution to knowledge in the field, achieving the desired result in the work, carrying out the responsibilities in the organisation, or by sensitising the raters/jurors to the rating task (Buel, 1965). The other measure often called `objective measure', is based on quantifiable outputs and/or incidents like papers published, patents held, technical reports prepared (e.g., Maizell, 1960), Ph.D. students guided, professional service records and other academic achievements and occasionally the frequency of `lucky accidents' of information acquisition called `information efficiency'. A major limitation of the second measure of productivity in relation to information and communication behaviour is that R&D staff seldom work on tasks alike enough for comparative purpose. Further, an artifact is that the communication and performance were not causally linked, but both were resultants of the same set of other human characteristics of which motivation is an important ingredient (Hall and Ritchie, 1975). For example, though the research environment definitely affects information-(processing) behaviour, the personal attributes may affect both the choice of environment and information- (processing) behaviour as scientists of any research environment are a self-selected population. The second artifact is that "...an environment is structured partly by the tasks that are preformed in it; tasks may affect both the environment and information-processing behaviour" (Parker and Paisley, 1970, p87).

Further, it is interesting to observe that productivity, communication and information use, citation and other activities of scientists and engineers are subjected to `Matthew effect'[1] `Success breads success theory', Lotka's law,[2] inverse law and 80/20 rule.[3] This essentially means that the frequency distribution of productivity, communication, information use, citation etc., will be highly skewed and a sort of inverse relation exists wherein few elites account for large amount of productivity or use or citation and majority account for a smaller proportion of productivity or use or citation. In other words, the rich are likely to get richer.

In a study about the relationship of organisational factors to scientific performance in an industrial laboratory, Smith (1966) found that formal internal meetings did not stimulate high performance. In fact, there existed a negative correlation between contacts with outside consultants and lecturers and level of performance. Further, informal contacts with colleagues within the organisation had no material effect on performance. Pelz and Andrews (1976) found that higher performance was related to a high level of communication with colleagues and there existed a correlation between performance and dissimilarity in research style and interest among colleagues of a work team. Maizell (1960) found that most creative chemists are characterised by spending more time reading scientific and technical literature, visiting companies, more often, examining more number of journals, consulting more often material from broader and related areas, that too on their own, and more often stimulated to ideas by reading, than by others. Further, creative chemists found the older literature of more value, and also found the technical information services offered by the library only modestly important. Maizell recommended that `spoon feeding' of technical information to both creative and non-creative scientists is not useful and considerations should be given to the most creative users separately basing on their information-gathering patterns. Paisley and Parker (1967) almost confirmed this by showing that individual productivity of research correlates strongly with the amount and diversity of information inputs of the individual. By and large, high performance and high academic achievements are also correlated with a high use of library. But the artifact that both high use of library/ performance/ creativity and particular pattern of information-behaviour may depend on a third unidentified variable. As a matter of fact, a study (Lubans,

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1970) showed that non-users of library differed significantly from users only in the fact that they were non-users.

Allen (1970) found that the use of organisational colleagues as a source of information is strongly and positively correlated with performance, and he believed that high communication is a cause of high performance and not vice versa. In a similar study (of 29 pairs of firms) about innovative role of information it was found that successfully innovating firms understood user-requirements better, had better relationship with outside experts, benefited from outside technology and had better external communication (University of Sussex, 1972). Frost and Whitley (1971) confirmed Allen's findings by observing that good performance leads to effective communication. Maizell (1960) identified that information-gathering habits and creativity are related and also postulated that motivation, extra-version/intra-version and emotional stability are also related to information-seeking.

There are not many studies correlating other personality-characteristics with information-behaviour. Rowley and Turner (1978, p112) emphasise need for such a study and say "... information habits are coloured by other personal idiosyncrasies, users may be grouped in a variety of permutations in an attempt to define their information needs and activities". Ford (1977, p44) also suggests that "we need to study information-seeking behaviour in the context of people's temperaments, interests, attitudes and total life situations. The insights and understanding to be gained from such studies would be of great practical value to the planners and providers of information-services".

7.2.3 Correlations with Organisational and Professional Characteristics

Lastly, many studies have attempted to relate organisational factors such as nature of work or function, various roles, responsibilities, organisational policies, available facilities, level of qualifications and status with information-behaviour (Ford, 1977). Hertz and Rubenstein (1953) found that the amount of communication varied with the function of a member in the research team (i.e.,higher among those with administrative functions and lower among those with design functions), with institutional rank (i.e., status), with the duration of the research project and with the size of the research team. Gralewska-Vickery (1976) found engineer-managers are the least likely group to use information centre, abstract journals and reading at work, but placed the highest value on informal and oral sources and made use of professional societies and personal contacts. On the other hand, she found engineer-practitioners (mostly field and laboratory engineers) valued professional societies more highly for news and information than for personal contacts and tended to attend professional meetings. The `linkers' were engineers concerned with transferring information between scientists and practitioners and they were intermediate in their characteristics relative to the other two groups (professors, lecturers, consultants and editors of industrial journals). They valued professional societies as a source of information, but were least likely to attend meetings or to prefer informal, oral communication, but read in the library, availed a variety of services of information-centres, were self sufficient and undertook searches for themselves.

Maizell (1960) found that supervisory responsibility and years of experience did not appear to be related to information-gathering patterns within the most creative chemists. The acquisition of doctoral degree did appear to have the effect of increasing the amount of technical reading done. Yet Crane (1971) pointed out the lack of sufficient studies to find differences in information-seeking between Ph.D. technologists and non-Ph.D. technologists. She quotes a study (Perrucci and Rothman, 1969) where considerable differences between Ph.Ds and non-Ph.Ds were found. In the same study, length of experience was found to be negatively correlated with both estimated knowledge of subjects studied at college and awareness of emerging new fields. Further, a high level of technical responsibility in the organisation was found negatively correlated with obsolescence. Scates and Yeomans (1950, p3) found that "information seeking activity of all types was strongly associated, statistically with academic qualifications".

The status of individuals in an organisation was found to be a key factor in information-transfer and informal communication networks operating at a higher-status level, leaving lower-status people to rely heavily on formal sources (Zaltman, 1968). On the other hand, information-acquisition can partially contribute to enhance the social status of a user when social interaction

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on the topic is expected (Clarke and James, 1967). Further, the nature and duration of the projects in which scientists and engineers are involved and phases and stages of project were also found to contribute to their information-behaviour (Robertson, 1974). Other findings about correlation of user-characteristics with specific aspects of information and communication-behaviour are presented in the subsequent pages along with a discussion of review of specific aspects of information-behaviour.

Footnotes

[1] Paisley (1968, p24-25) has called for replacing the `tired labels' such as basic versus applied, scientist versus technologist and formal versus informal communication by Merton's theories (1957) of the middle range which are neither too close to information use data nor too far removed into systems theory and cybernetics.

[2] Papyrocentric' is first used by Price (1969) to refer to the over-riding compulsion of scientists to publish in the open literature and the opposite, which is applicable to technologists is called `Papyrophobic'.

[3] Cosmopolite' and `Localite' are sociological concepts based on whether occupational recognition is centered within one's employing organisation or not. `Cosmopolitans' or `Professionals' seek status within their professional group, have deep commitment to their speciality, strongly committed to distinctive professional ideology and seek approval and recognition of peers outside-the-organisation as well as those within. `Locals' or `Organisationals' have primarily loyalty to the organisation for which they work, seek advancement up the managerial hierarchy, identify with organisational goals and values, and seek recognition primarily from their organisational superiors (Goldberg et.al., 1965, p704).

[4] Merton (1968) first proposed `Matthew effect'which was based on Matthew's Gospel `For unto every one that hath shall be given, and he shall have abundance; but from him that hath not shall be taken away even that which he hath'.

[5] The number of scientists who produce `x' papers is found to be proportional to 1/x2.
[6] If all the items are arranged in order of value, 80% of the value would come from only 20% of the items, while the remaining 20% of the value would come from 80% of the items.

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CHAPTER 8

MOTIVES AND PURPOSES OF SEEKING INFORMATION

Behavioural scientists have propounded many motivational theories and they are quite useful in understanding information-behaviour of users. Some of the important motivational theories/models are: Mc Gregor's Theory X and Theory Y, Vroom's Expectancy Theory, Skinner's Behaviour Modification Theory, Mc Clelland's Achievement Motivation Theory, Maslow's Need Hierarchy and Herzberg's Motivational and Maintenance Factors. Interestingly, all the models are related to human needs and almost all of them form indirect bases for different information-behaviour. For example, Vroom's Expectancy Theory says that motivation is a product of valence and expectancy, where valence refers to the strength of a person's preference for one outcome in relation to others and expectancy is the strength of belief that a particular act will be followed by a particular outcome (Davis, 1977, p60). The earlier discussion of `perceived value of a source of information' and consequent preference/use of a source of information is based on this cognitive motivation theory. Secondly, Skinner's Behaviour-Modification Theory says that behaviour depends on its consequences or a person tends to repeat behaviour that is accompanied by desirable consequences (i.e., reinforcement) and tends not to repeat behaviour that is accompanied by undesirable consequences (p63). This theory, based on external consequences of an action, very well explains the consequences of information search failures and successes, and how the available facility/service determines or affects the user-behaviour as well as apathy towards information-service and innovation (Havelock, et.al., 1969, p4.10).

8.1 Motives of Seeking Information

Most of our actions, directly or indirectly, are caused by motives which may be simple or complex. Motives are often concealed and operate at a subconscious level, and hence one has no control over them. Motivation is based on important attitudes which are closely tied into an individual's aspirations, desires and so on (Havelock et.al., 1969, p4.23). Motives are volatile in nature, and understanding the purpose of seeking information may allow for accounting gross individual differences but introspection on motives is difficult to validate (Parker and Paisley, 1970, p90). Motives at a more conscious level become goals and purposes. In this sense, as far as ISB is concerned, motives are more internal and individual-oriented than purposes. On the other hand, purposes are more external to an individual and are organisation or environment-oriented. Motives and purposes necessarily overlap, depending on the conscious recognition by individuals. For instance, an urge to write and publish may be a motive and at a more conscious level, writing a paper on specific topic becomes a goal or a purpose. Behavioural research has shown that motives initiate a chain reaction leading to needs which in turn lead to wants, then to tensions, actions and the resultant feeling of satisfaction or dissatisfaction.

There is no significant research done (except certain casual references) about motives behind seeking information, although ignorance about motives and purposes of seeking information, information-needs and requirements places the study of use of information in a wrong perspective. The studies done so far have frequently failed to distinguish motives, purposes, needs and requirements in relation to information. Many have used them interchangeably[1]. In the whole chain from motives to use and satisfaction/dissatisfaction, it is the use which is most concrete and motives the most abstract and cognitive in nature. Hence, from use one cannot trace backwards the need, purposes and motives since many other intermediate factors such as availability of service, accessibility, `ease of use', perceived value, initiative, etc., act between motives of seeking information and actual incident of use of information.

Maslow (1969, p92),in as early as 1950, asked a dozen scientists about how they picked up line of work, field and -problem, what main rewards (the gratifications, the pleasures, the kicks, the peak moments of highest happiness) they get out of work, what keeps them at it and why they leave their work. Impressed with the variety of covert motives that impelled scientists to their work and kept them at it, he concluded that "as with other human beings, their world-view,

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their pleasures and satisfactions,their likes and dislikes, their vocational choices, and their styles of work were in part an expression of their characters".

The motives for reading in the context of mass communication has been the concern of sociologists almost exclusively (Hatt, 1976, p47). Menzel (Columbia University, 1958) felt that achievement, curiosity, self-evaluation and affiliation exist in information-seeking situations. In another study (Paisley, 1965), it was found that ego has increased the amount of information-seeking in a low-publicity condition but decreased it in a high-publicity condition as compared to situations where ego involvement is absent.

The main motivation of a scientist is to publish and seek peer recognition and that of a technologist is to produce. Achieving the desired result or even excellence in the current work, and, in the process,to establish and maintain contact with current work and scientists elsewhere, and seeking information relevant to the ongoing or planned work is an important motivation of research workers. In support, 56% of respondents in a study (Slater and Fisher, 1969, p12-13) said demands arising directly from the central subject field of current work as the motivation to seek information, compared to 15% on peripheral or unfamiliar subjects encountered in the work and 10% on practical problems at work. The two main reasons for reading scientific and technical literature by scientists are (i) to acquire or recover specific information and (ii) to discover new items of information hitherto unknown (Meadows, 1974, p103). In industry information is needed to innovate and further, in policy-making and planning, scientific information is needed mainly not for innovation but for control (Gray and Perry, 1975, p6). The rank order of motivation1 for seeking information as found by Slater and Fisher (1969, p32) is as follows: need for background information ie., to know about past work in the field (22%), keeping up-to-date ie., to know what others are planning and doing (17%), material for essays (16% students), to prepare for and supplement lectures (12% students), information about a process, method, or technique needed to carry on with a current project (10%), information needed to instruct, train or inform others (8%), data, equations, facts and figures (8%), new ideas and stimulation (8%), prepare for examination (7% students), planning a project, experiment or test (6%) and information on equipment, apparatus, raw materials, etc.,(3%).

8.2 Purposes of Seeking Information

The purpose for which information is sought is one of the key factors often neglected, or treated only superficially in user-studies (Ford, 1977, p14). Information sought by a user is often, for a particular purpose - current or anticipated and the use of an item of information or even source is optimum when a perfect match occurs between the need arising out of the purpose and the incident of use. Compared to motives of seeking information, the reasons or purposes of seeking information have been better explored in the past.

The nature of work of users and the different roles they play are the starting points for understanding the purposes of information-seeking.[1] For example, the limited use of journals by engineers is attributable to the fact that engineers do not encourage the continuous integration of new ideas within existing practice (Wolek, 1969). They spend 90-95% of a project time in prototype phase compared to limited time (5-10%) spent on systems-definition phase and try to build not the `best' but a `better' technology than before by focusing on a limited number of alternatives. The prototype model becomes progressively more `frozen' and decisions irrevocable as the project progresses.

Menzel and Voigt have given two fundamental, and yet different, ways of grouping purposes of seeking information. The functions or purposes of seeking information identified and related to sources of information by Menzel (Columbia University, 1958) are: (1) Keeping abreast of current developments, (2) Brushing up or reviewing the recent years' work in an area, (3) Certifying : giving testimony to the reliability of a source of information, (4) Redirecting attention : broadening one's area of attention, (5) Eliciting reactions or responses or feedback to own statements or assertions, (6) Locating : accessing the position of one's topic or orienting one's own work within the totality of research endeavours, and (7) Answering specific questions for further research.

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Most scientists spend a large portion of their time with the purpose of knowing what other scientists have recently done or are doing, to keep up-to-date with the current progress and to give meaning to their own works, and Voigt (1959) has called it the `current approach' (comparable with purposes 1,2, and 6 of Menzel). The next greatest use of information by scientists arises out of `everyday approach' for which information centres and bibliographical services are of a limited use1. The `everyday approach' arises in the course of work requiring specific piece of information, a bit of data, a method, information about apparatus construction, an equation, an explanation of an observation, etc., and this is largely met by inter- personal discussion with colleagues (comparable with purposes 3,5 and 7 of Menzel). The `exhaustive approach' (where `exhaustive' is a relative term) arises less often and has the purpose of knowing current research in progress and depends to a great extent on formal and documentary sources of information. This need arises more with pure scientists than applied scientists and at the time of starting a new investigation, presenting results in the form of reports, writing a paper, preparing for a talk and submitting patent application (comparable with purposes 1,2,4 and 6 of Menzel). All other later analyses of purposes of seeking information like that of Gilmore, Garvey, Havelock, Blaxter, Marquis, Allen, etc., can very well be fitted into these two most fundamental frameworks of Menzel and Voigt.

The above discussion has not covered the motives and purposes of scientists and technologists arising out of a derived or hidden objective falling outside the work situation. For example, Wood and Ronayne (1972, p12-13) found that chemists in their sample sought information for recreational, habit motives and for the purpose of maintaining a sense of social contact with other scientists (i.e., conversational and social use).

Menzel (Columbia University, 1958, p67 and 80) in an exploratory study found that self-scanning of journals was ranked first by 67% of the respondents for keeping abreast with current developments. Menzel also introduced the concept of `radius of attention' to specify the breadth of the area within which scientists feel responsible for keeping abreast to varying degrees. In another study (Case Institute of Technology, 1960) physicists read journals for specific information 58.7% of the times (as against 35.5% in case of chemists) and the rest of it was undirected browsing. Rosenbloom and Wolek (1970, p39-42) found that 47% of searches were for problem-solving information, 21% for competence-oriented searches and the engineers (53%) were slightly more likely to undertake a specific search than scientists (42%) and far less likely to try and improve their general competence (17%) than were scientists (25%). The lack of a sufficiently strong motive to keep as fully informed as possible (Parker, 1973, p10-11) and collecting information for more than one purpose with majority collecting procedural information for design/development projects (Garg and Ashok Kumar, 1984, p70) were also noticed in two different studies.

Footnotes

[1] For example Lin and Garvey (1972, p14) divided the discussion of information needs into types of information needed and factors that generate information needs, that is, motives and purposes of seeking information.

[2] This is not to underestimate the equally significant role played by attributes of individual users. In fact the dependence on literature was found to be related more to the problem-solver than to the problem (Scott, 1960, p61).

[3] This is a clear example where motives and purposes are interchangeably used and nature and type of information required is also mixed with them.

[4] The fallacy in thinking that the solution to documentation problems lies in large national or regional information centres tems from the erroneous belief that a scientist generally needs all or most of the information available on a subject which is not true as far as `everyday approach' is concerned. Large information centres are of limited value as far as this approach is concerned (Voigt, 1959, p185).

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CHAPTER 9

INFORMATION NEEDS AND REQUIREMENTS

The information-requirements refer to a lookout for a sort of relevance of information to a given user and to his areas of concern and interest, likes and dislikes. In the process it is to know the amount of irrelevant information he is prepared to tolerate. Relevance is not a simple property inherent in information, but varies with content, format, context, the variety of uses of information as well as user himself (Cott, 1970). "The selection and reception of the information will depend upon the individual's conception of his own needs; one man's information is another man's noise ..." (McGarry, 1975, p58).

There have been numerous studies as well as reviews about user-needs and requirements, but with little accumulation of body of knowledge. Meaning, scope, levels and types of information-needs have varied very widely. Problems of defining terms and concepts, lack of theoretical frameworks and other problems and issues of an empirical study of information needs and requirements persist(Brittain, 1971, p 2). The successive reviewers like Menzel, Martyn and Crawford have pointed out (in ARIST, 1966, 1974 and 1978) the extremely complex, varied and difficult-to-measure nature of information-need. Menzel has even preferred to call `information needs and uses' as a study of the behaviour and experiences of scientists and technologists. Hatt (1976,p42-43) called them `user behaviour studies'and Wilson(1981) advocated that the term `information-needs' should be replaced by `information-seeking towards the satisfaction of needs.'

While discussing the issue of information-needs, a natural assumption is to consider the needs as perceived by the users. But some are of the view that there is a need to create information-needs among users if they do not exist (Harris, 1985, p2) and that information-seekers may be ignorant of the information that would be useful to them (Oldman, 1976, p23).

Dervin (1976) has analysed the taxonomy of everyday information-needs of average citizen and proposed a study of six linkages among the following four elements: (1) The individual citizen, (2) Information-needs, (3) Information-sources, (4) Solutions to information-needs. Each one of the linkage represents interaction between two elements. Havelock(1976,p211)provided a linkage model/process describing the internal problem-solving cycle within a user who is related to an external resource.

As noted earlier, Information-needs are affected by many factors. Range and knowledge of information-sources/facilities available, varieties of uses to which information will be put, the background, motivation,professional orientation, discipline, type and area of work and other individual-characteristics of the user, the social, political and economic system as well as the conseqences of information-use (Cronin, 1981, p39; Lin and Garvey, 1972, p8-10). Due to this contingency nature, generalised one-time conclusions about information-needs of users is impracticable. Of all the factors influencing or determining the user-needs, two factors which may not always be congruent, are the corporate objectives of the organisation where the user is employed, and the needs of the individual user.

9.1 Typology of Information-Needs

Studies relating to `information-needs' categorise needs as `perceived needs' and `actual or idealised needs', `immediate needs' and `deferred needs', `continuous needs' and `discrete needs', `regular' and `irregular needs'. Further, information-needs could be unexpressed or expressed/articulated, felt or unfelt, dormant or delitescent. In addition, information-needs of users can be expressed in terms of time (i.e., urgency), content and amount or quantity of information. Accordingly, information-needs have been classified as needs for single facts or exhaustive information, uptodate, historical or current information, technical or business information. However, information-needs are frequently determined in terms of kind of message i.e., nature and type of information, the types of document embodiments of information needed and the purpose of use. Many studies have investigated need for channels, but only a few have

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focused on the need for substance or nature of material in terms of characteristics of texts(Lin and Garvey, 1972, p12).

In the past, each study has adopted its own classification based on the nature and type of information sought by users. Some of the significant classifications are personal, technical and task- related information (Ford, 1973, p88-89), current, specific and exhaustive information (Voigt, 1961, p4), theoretical information, results and data and methods and procedure information (Columbia University, 1960), educational information, methodical or how-to-do- it information and task-related information (Auerbach Corporation, 1966). Many others like Slater and Fisher, and Hanson have attempted to determine the amount or level of information requirements in core versus peripheral areas of interest of users. In addition, the nontechnical information required, information requirements in new fields versus old fields have also been attempted. The profession and organisation-oriented, work-related information-needs are the main information-needs in all these studies apart from day-to-day personal needs, life-long learning or educational needs, and needs about the governing rules of the society around user.

9.2 Nature and Type of Information Sought

The findings of different studies on information requirements of scientists, engineers, technologists and technicians roughly indicate that basic S&T information, background information and everyday information on one hand and technical, physical, design and other technical data, facts or figures, product, process, method and equipment information on the other hand have occupied the highest position. For example, need for basic S&T knowledge (82%, Shuchman, 1981, p 32-33; 1982, p 106-109) by American industrial engineers, everyday information (68.8%, Wood, 1967, p 212) by British mechanical engineers and background reading coupled with uptodate information by users of British technical libraries (27% + 19%, Slater and Fisher, 1969, p 32-33, 36,47 and 49) as well as American technical libraries (49%, Rawdin, 1975, p 41-42) ranked highest in some studies. On the other hand, performance-characteristics and specifications (42%) followed by design technique, experimental processes, procedures (13%) ranked highest in DOD user-study (Auerbach, 1965, p 1-19). A closely similar situation of 33% seeking equipment information, properties of materials, design and performance of plant followed by 11% seeking operating procedures of equipment and plant was found by Cole (1958) and respondents of Herner and Herner (1959) sought process and method information (25.5%), physical, chemical and engineering properties of materials (24.6%), apparatus or equipment information (16.8%), physical and chemical constants (16.4%). A hefty 64% of respondents wanted facts in Raitt's study (1984, p 204-208). Thus analysed the World Federation of Engineering Organisations (WFEO, 1979, p 15) :"...the most proper form of information for engineers is the factographic information, analytical-synthetical elaborations and state-of-arts"1. These types of factual data ranked second in the studies of Shuchman, Rawdin, Slater and Fisher. More than two decades ago, Hanson (1964, p 67-68) summarised that one-fifth of the times, scientists, engineers, technologists and technicians need a figure or a single simple fact, between a quarter and a third of the times adescription of an object, a process, a method or procedure and remaining half of the time general information and ideas from background reading. At the lower end of the need came the business and general information (16%, Shuchman, 1981, 1982), exhaustive information (11%, Rawdin, 1975, p 41-42; 18.6%, Wood, 1967, p 12), ideas, advice and opinion (respectively by 23%, 10% and 8%, Raitt, 1984) and non-technical information (18%, Herner and Herner, 1959).

There were some interesting results about information-requirements of users in core areas as compared to peripheral areas, new areas as compared to developed areas and urgency of demand for information. Slater and Fisher (1969) not only found highest success rates of searches[1] (67%) in core subjects than peripheral subjects (58%) but also found higher demand for information on core subjects in academic libraries and on peripheral problems in other types of libraries. The demand for information on core areas was highest (61%) among scientists and lowest (46%) among engineers and demand for information on peripheral and unfamiliar subjects was highest among engineers compared to skilled workers, technicians, teachers, etc. In support of this, Wood (1967, p 212) also found that 27.5% of the mechanical engineers needed information outside mechanical engineering. Further, the highest demand for information on practical problems was from

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engineers (16%) and lowest from scientists (6%) (Slater and Fisher, 1969). Hanson (1964, p 67) in his analysis of `acts of library use' found that a third of use was for information on a specific subject and remainder mainly for browsing or reading current journals. Back (1962, p 20) speculated that scientists in upcoming and new fields had broader information-needs than those in fairly developed fields. Lastly, by introducing a crude measure of urgency of information-need in the survey, Slater and Fisher (1969) found that 59% of their respondents had some degree of urgency and for 30% time was no object.

9.3 Correlation of Information-Requirements with User-Characteristics

The information-needs and requirements have been correlated in the past with discipline (by Singh, Aims, Gray and Perry), nature of employment (by Hanson), nature of work (by Wilson, Gray and Perry), status (by Singh) and experience (by Garvey and others). Unfortunately, the important factors or characteristics which substantially affect user-needs and requirements are not clear and correlation of information needs with many other user characteristics like educational level, performance, etc., have not been dealt with sufficiently in pragmatic studies.

Aims (1965) hypothesised that the information-needs of engineers differ widely from those of physicists and chemists and Gray and Perry (1975, p 53) speculated that engineers differ widely from those of R&D workers in their information-needs. The differences in needs and demands for information are more strongly related to the kind of employment and type of organisation than the discipline in another study (Hanson, 1964, p 69-70). An observation that electronics and telecommunication and industrial engineers cite to the maximum from other disciplines (B.N.Singh, 1981, p 183) is highly vague as an equally strong interdisciplinary need for information is expected in many other disciplines too. Surprisingly, and contrary to others, Raitt (1984, p 255) has generally confirmed his hypothesis that "...the information needs and communication patterns of scientists and engineers in general are similar and cannot be readily distinguished."

Shuchman (1981) has tried to relate five variables to the nature and type of information sought by American industrial engineers and found that the job activity and type of industry appeared to make the most consistent difference. The occupational role and the nature of work of user is considered to be the most important clue for understanding personal information-gathering behaviour by Wilson (1977, p 50). As engineers perform a wide variety of functions, their information-needs are quite varied depending on their respective functions. For example, design engineers need numerical data in a compact and easily usable form (Gray and Perry, 1975, p 55). A recent contrary finding is that the status of the scholars belonging to the research community did not appear to be influencing their information needs (B.N.Singh, 1981, p 182). In another survey, it is found that the least experienced scientists have greater information-needs than the most experienced (Garvey, et.al., 1975, p 501).

Most of the above results are either speculative or theoretical in nature and are not supported by a rigorous analysis of hard data. Past studies have not addressed the information-needs and requirements of under-privileged and deprived users and nonusers and have also not explored the ways of dissipation of unmet needs (Ford, 1977, p 20).

Footnotes

[1] Based on the replies from national members, WFEO (1979, p 21) identified eight types of data most needed by engineers i.e., (i) property (ii) design, (iii)product, (iv) standards, regulations, laws (v)production and manufacturing procedures, (vi) companies and their marketing products, (vii) market information and (viii) socio-economic and ecology information.

[2] It is possible that respondents ignore failures of searches on areas not really connected with work and hence the actual difference in success rate might be even more.

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CHAPTER 10

ACCESS TO INFORMATION AND WAYS AND MEANS OF ACQUIRING INFORMATION

Having seen the motives and purposes of seeking information and nature and type of information required, it is natural in the study of information-behaviour of users to raise the questions relating to how users reach or interact with sources of information. How do users and documents come together? How do they discover bibliographic references to formal sources? Do they search for information themselves or delegate it to others? Is such searching for information deliberate? Is information largely obtained in an accidental way? How much time and efforts are expended by users in gathering information? Some of these questions need to be answered to know the information-behaviour of users.

10.1 Sources of Reference (Bibliographic) Information

Interestingly, the user researches done so far, have shown slightly greater consistency in their findings on use of sources of reference information and how users discovered reference-information than other aspects of information-behaviour. Recommendations of colleagues and experts, citations in current reading materials, chance acquisition, browsing and searching on library shelves, indexing and abstracting services and library catalogues in that rank order have yielded reference information to users. The findings of Herner, Urqhart, Bernal, Barber and many others closely follow this generalisation with variations due to methodologies adopted and with a special note about users going to library shelves frequently rather than to card catalogues and enquiring with colleagues rather than searching abstracting and indexing journals.

Recommendations of the colleagues yielded one-third of the references in two studies (Voigt, 1959, p 179-180; Hanson, 1964, p 71) and current reading materials provided one-third of the references in one study (Voigt, 1959, p 179-180), one-fifth of references in another study (Raisig, et.al., 1966) and a little over one-fifth in another Indian study (B.N. Singh, 1981, p 172). Surprisingly, as many as 70% of references were found by chance in two studies (Shaw, 1971, p 84; B.N.Singh, 1981, p 172). A very gloomy picture of the role of organised information system indeed. The other sources of bibliographic information like working bibliography, memory, personal indexes, library card catalogues, accession lists, librarian and library staff, etc., have just yielded one-fifth or much less references.

About the use of library card catalogue as compared to direct consultation of books on shelves, many studies have clearly established the fact that most of the users prefer to go straight to the shelves than consulting the card index, and even avoid the catalogues (Meyer, 1977, p69). Further, catalogues are often approached as a technical problem, than a problem in communication and as a result, they act as formidable barriers than keys to the contents of a library (Line and Tidmarsh, 1966, p 128). Strain (1973, p 1446) found that library materials are selected by browsing as against using the card catalogue in the ratio 3:2. There is no extensive research about the browsing activity of users. As such too little is known about it. However, catalogue-use studies have confirmed that a majority of the searches are for known items (Lipetz and Stangl, 1968, p 137-139), the rank order of approaches is subject headings (80%), personal authors (50%) and title (43%) (Kenney, 1966, p 200; Sridhar, 1986) and the memorability ranking of the attributes is subject headings, title and authors (Ayres et.al.1968; Tagliacozzo et.al.1970; University of Chicago, 1968).

Some studies have reported a rather low usage of abstracting and indexing journals by scientists and a much lower usage by engineers and technologists. In one of the earliest studies, Urqhart (1948) found that U.K. scientists got 33% of references in abstracts and digests. But subsequently it was found that 38% of U.K. physicists had their references from abstracting journals (Urqhart, 1965) and 48% of US physicists used abstracts (part of the time as substitute and 6% only as substitute never as surrogate) for references (Gray, 1950, p 417).

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Abstracts and indexes are used by 33.5% of engineers in general (Davis, 1965, p 31), 20% of electrical and electronics engineers (Scott, 1959) and 14.9% of mechanical engineers (Wood, 1967, p 214). Under-utilisation of abstracting service is attributable to the orientation of scientists towards literature, less as recipients (users) than as donors (producers) (Meadows, 1974, p 110). In this connection, it is also observed that the styles of information-seeking differs between British and American scientists (Parker and Paisley, 1970, p86). Interestingly, chemists were found to use abstracts more than physicists (Aims, 1965, p 86) and chemical engineers (51.5%) more than engineers in general (33.5%) (Davis, 1965, p 31), ostensibly due to the central position held by the Chemical Abstracts. This seems to be a very good example of the effect of available information facilities and services on information-behaviour of users. Though it is not generally the lack of awareness which is the reason for under-utilisation of abstracts and indexes, Randalls (1959) claims that library publications have succeeded in creating an awareness about the existence of literature. Further, the more creative scientist is less likely to seek assistance from library staff, and the chances of pure scientist seeking the assistance of the library staff is much less than an applied scientist or technologist (Meadows, 1974, p 124).

10.2 Accidental or Unplanned or Chance Acquisition of Information

In addition to getting bibliographic references by chance, users do get actual information itself in an unplanned and unintentional way in unfocused browsing and scanning of literature which is termed accidental acquisition of information[1]. An important role is played by accidental acquisition of information in the work of a researcher with individual accidents summing up to a systematic regularity in terms of occasions, places and times in an information rich environment where users can depend reasonably on such accidents to keep up-to-date and even to learn answers to specific questions (Columbia University, 1958, p 30-49). Though relatively less attention is paid in the past, on this area of user-research, the general finding is that an average researcher finds useful information accidentally somewhere between one-third (Rosenbloom, et.al.1965) to one-half of the instances of his total acquisition. It is "... discouraging to find that information is found by chance as often as it is by formal use of bibliographical tools" (Skelton, 1973, p 144). The useful information comes by chance from articles and reprints (45%), persons other than one's work-mates, colleagues, ex-colleagues or suppliers' representatives (17%) and books (12%) as well as due to secondary activities of users like that of editor, referee, occasional lecturer, visiting researcher, or consultant (Columbia University,1958, p41-42).

In a journal-reading survey, 58% of the recent articles of direct use came to the attention of respondents by chance, and 44% based on recommendations of colleagues (Scott, 1959, p 114; 1966, p 29). In another study, 22% of the bio-scientists were able to describe some information that had reached them accidentally and had a direct bearing on their most recently completed research (Bernard, et.al. 1963/1964).

The so-called lucky accidents have made some give thought to the reasons and probe how they occur. The process of `peripherisation' as a preparation for inter-personal contact of user (Wolek, 1972), the need for each scientist to specialise in two or more quite different specialities (Price, 1961), the superimposition of separate cognitive matrices (Koestler, 1964), the need to have open information-system as against perfect and closed system (Menzel, 1970), need for increasing the size of the team (Line, 1974, p 48) and the identification of a central core area and a largely ill-defined peripheral area (Martyn, 1975, p 16-17) are some of the interesting observations and recommendations towards increasing the `lucky accidents' of information-acquisition. All these suggestions have directly or indirectly pleaded for a widening of the area of attention and increasing the browsing activity of users, and not to strive for too much of precision in current awareness-services with the understanding that apparently irrelevant (or non-specific) information plays an important role in the process of problem-solving (Menzel, 1972, p 48; Line 1974, p 48).

About the frequency of accidental acquisition of information, it was found typical of both scientists and social scientists in one study (Skelton, 1973, p 146); less among scientists in government laboratories than those in academic and industrial sectors in another study (Menzel, 1966, p 58) and highest among users from government than others in yet another study (Slater and Fisher, 1969, p 15). Much attention has not gone into the interpretation of these inconsistent results and exploring ways and means of increasing accidental acquisition of

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information by manipulating the system and its organisation and testing the suggestions mentioned earlier (Menzel, 1972, p 48; Bernal, 1960, p 438).

10.3 Delegation of Information-Gathering Work

In a typical problem-oriented information-seeking situation, a user can either search for information on his own or delegate this task to others (junior colleagues and library staff). Delegation of information-gathering task may become necessary for more than one reason like lack of time, as a part of division of labour among colleagues in a collaborative work-team, lack of access and/or acquaintance with sources of information, etc. The main issues are the extent of delegation, reasons for delegation, type of searches delegated, circumstances under which delegated and who delegates to whom. Most of the studies carried out so far have given more importance to find out whether the scientist or engineer is willing to delegate literature-search (some times search for information) to library staff. Library researchers were not much worried to find out the possibility and extent of delegation of information- gathering task to junior colleagues and others. It is generally found that the delegation to library staff is very low (Friendlander, 1973) and libraries play a passive role in research-process. Even for a systematic literature-search, the librarian is not consulted in more than 70% of the cases by U.K. physicists and chemists (Aims, 1965, P 88). In another U.K. Survey, users depended on themselves for literature-search[1] 55% of the times (Hanson, 1964, p 71) and the same applied for 24% of U.K. atomic energy scientists (Hogg and Smith, 1959). On the other hand, 29% of the industrial technologists (Scott, 1966, p 33) and 72% of social scientists (Line, 1971, p 25) were not willing to delegate at all. Seven percent of social scientists delegated extensively[2] (Line, 1971, p 425), 66% of atomic scientists delegated sometimes (Hogg and Smith, 1966, p 33), and 58% of industrial technologists were willing (plus another 6% partially willing)to delegate information-search to library staff (Scott, 1966, p 33). In another survey 7% did joint search with librarian and another 34% sought help of librarian for literature-search (Hanson, 1964, p71). It is important to note that when we talk of delegation of information-gathering, we refer to how often delegated. There cannot be a user who delegates on all occasions.

Lack of willingness on the part of the user to delegate information-searching task to library staff depends on the nature of the information and nature of the problem or work for which information is needed. Some users do believe that others cannot analyse and digest information (Myers, 1970, p27) for lack of a scientific empathy between the requester and the searcher (Herner and Herner, 1967, p 28). This role of the librarian as a mediator between information- sources and the user is a very significant issue in user-research which needs to be settled soon (Line, 1971, p 426). The nature of information-gathering work delegated was collection of factual data followed by an exhaustive literature-search in social sciences (Line, 1971, p 425) and factual data followed by a few latest references (Raitt,).

Generally, scientists were found to delegate more than social scientists (Skelton, 1973, p 147; Bebout, 1975, p 43), engineers than scientists (Slater and Fisher, 1969, p 46), pure scientists than applied scientists (Vagianos, 1971, p 86) and applied or experimental researchers than theoretical or historical researchers, older, senior and more experienced than newer, younger and less experienced, factual data collection than theoretical or conceptual material and retrospective search than current search (Line, 1971, p 425). The reluctance of scientists to delegate is assumed to be due to a highly-specialised, creative and personal nature of their work. Raitt (1984, p 215 and 234) found that scientists and engineers of aerospace establishments were three times more likely to ask the librarian for information than scientists and engineers of international organisations, and a bulk of such persons were physicists (30%) in aerospace establishments. Further, he found that one-fifth of his respondents visited the library very often to do their own literature-searches and only 6% visited the library very often to request a literature-search. It indicates that heavy users of literature do not generally delegate extensively (Herner, 1954) and as collaboration increases or the team size increases, the researcher is more likely to discuss his work with his colleagues and delegate to one or more of them. Further, a more experienced and sophisticated user of literature uses fewer tools and techniques for search.

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10.5 Time Spent on Information-Gathering Activities

As time is limited for any purpose including purposive-communication and information-gathering, it is believed that normally users use their time economically and judiciously among alternative demands, and in relation to the benefits or rewards expected. Spending time in such activities necessarily involves physical, intellectual or cognitive efforts. An optimisation of time, effort, money on the one hand and expected rewards on the other take place (Wilson, 1977, P 54). In the process, those who already know more are better able to find more with least efforts (a manifestation of Matthew effect and `success breeds success' phenomenon). Secondly, as more and more time is expended on gathering information (about an issue), the later hours of time yield (relatively) lesser information conforming to the law of diminishing returns. User-studies have attempted to measure time spent in information-activities by users either in terms of time spent on scientific communication or time spent in searching information or time sent in reading literature. Any measure of time spent on information-gathering is meaningful and comparable if it is restricted to purposive-work related information or for information helping to build professional competence.

A typical scientist was found to spend one-third of his working time on scientific communication, followed by 10-13% on business communication, 20-29% on equipment set up and use, 6-12% on thinking and planning, 6% on data treatment (Halbert and Ackoff, 1959; Jahoda, 1969). Those who investigated time spent on information-searching also found that about one-third of the working time or 7-14 hours a week has been spent by scientists (Schussel, 1969; Gilmore, et.al. 1967, p 41-42; Garg and Ashok Kumar, 1984, p 71).

It was also found that scientists spend more time on oral communication (58%) than written (42% which includes 27% written but unpublished) communication (Halbert and Ackoff, 1959). Japanese scientists spent 2-5 hours a week on oral communication (Kotani, 1962, p 323). In a recent study, surprisingly, Raitt (1984, p 153) has concluded that his respondents spend most of their time in written communication rather than oral communication.

A typical scientist is found to spend 7.2% of his working time (Halbert and Ackoff, 1959; Tornudd, 1959, p 181; Shaw, 1971, p 20, 49-50) on reading literature and this time is approximately divided equally between reading for a specific use/purpose and reading for general information. While Vickery's (1961, p 263) observation that the American and British researchers spend 4-5 hours per week for reading scientific documents is on the higher-side, Raitt's (1984, p 228) finding that a majority of his respondents spend 2 or less than 2 hours per week on reading is on the lower-side.

On reading scientific periodicals alone, physicists and chemists were found to spend 2.2% of working time or 2 hours per working week (Case Institute of Technology, 1960, p 2-10). But the estimate of time spent by the Japanese scientists (14 hours per week, Kotani, 1962, p 323) and time spent by aerospace and avionics engineers (1-5 hours on technical magazines, 40 minutes on professional journals and 40 minutes on reports, Lufkin and Miller, 1966, p 179-180) appears to be on the higher side.

Inspite of wide variations, Knox (1973, p 416) observes that there may not be a change in the amount of time spent by a scientist or engineer in interacting with information-systems in the last 25 years. There were also attempts in the past user-research to see the variations in time spent on information-gathering at different stages of a project, at different places and relating such time to attributes of users. Allen and his associates concluded that information-gathering is greatest in the initial-period of each project, with literature-search and outside-consultation contributing to the maximum at this stage. The literature-search quickly decreased as the project progressed and replaced it in importance by inter-personal communication (Allen, 1964; Allen and Andmen, 1965; Allen et.al., 1966).

Interestingly, scientists in smaller countries spent more time in reading (2-3 hours more in a week in Scandinavia than in U.K.) than those in bigger countries (Tornudd, 1959; Meadows, 1974, p 102-103), non-supervisors than supervisors (Raitt, 1984, p 228), research chemists in University spent more (16.5 hours a week) time on scientific communication than those in industry (10 hours a week) (Martin and Ackoff, 1963; Columbia University, 1960) and relatively more time

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(2/3) is spent on undirected browsing by chemists than physicists (2/5). Surprisingly, the amount of time spent on reading was found to be unrelated to performance of users and `discussion stars' did not differ from others in time spent on reading (Hall, 1972, p158 and 201). A negative correlation of time spent on scientific communication with that of equipment set up and a positive correlation with that of thinking and planning in research projects was also reported (Parker and Paisley, 1970, p 86; Halbert and Ackoff, 1959). An Indian study showed that `time spent' is independent of specialisation, qualification and rank of user-scientists (Garg and Ashok Kumar, 1984, p 71). Thus the findings are quite varied and less consistent for comparison.

Footnotes

[1] Coming across one relevant piece of information while searching for another, having an item brought to one's attention unsolicited by a colleague or learning relevant information while visiting another laboratory for a different purpose is termed accidental acquisition of information (Menzel, 1972, p 40).

[2] Today, with on-line search facilities, the situation may be different.

[3] Interestingly enough, 73% of those who were willing to delegate partially and 61% of those willing to delegate extensively did not do so. 1984, p 301) in science and engineering.

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CHAPTER 11

SOURCES OF INFORMATION

Investigation of dependence and use of various channels or sources of information is an extension of the study of purposes of seeking information and the nature and type of information required by users. All the three aspects are closely inter-related. Information-seeking is a purposive and adaptive process wherein there is no assurance of success for a search. In the process, several sources of information should be made to act synergistically to bring about the effective transmission and use of a message (Menzel, 1966, p 1000) which needs a high-degree of co-ordination among sources (Johnston and Gibbons, 1975, p 34). Considerable research has been done about various sources of information used by scientists, engineers and technologists. The studies have sought to know what sources are required and used by users; how use of different sources varied with various user-characteristics and how they are ranked or the preferred sources of information either for all purposes or for a specific task. The rank choices are often based on the amount of information yielded by a source or the amount of time spent on a source or perceived utility of a source or frequency of use of a source. All these measures directly or indirectly attempt to find out the overall degree of dependence of users on various sources[1].

The factors which decide the choice of a source, apart from task and purpose of seeking information, are physical proximity, accessibility, perceived quality and utility, `ease of use' and previous experience about the source or acquaintance with the source. These factors are very much inter-related. It is found that accessibility and `ease of use' are stronger factors than perceived quality and the amount of information expected to yield by a source. An irrationality (i.e., a curious filtering process) is that engineers use channels in proportion to accessibility and `ease of use', but they accept ideas from those channels in proportion to technical quality (Gerstberger and Allen, 1968; Rosenberg, 1970). It is fairly well established that the `least effort' principle and Mooer's law operate in the choice of alternate information-sources or channels. In other words, channels compete with each other in terms of time, cost and efforts of users. This does not mean that many sources of information are non-complimentary.

The formal and documentary sources of information alone do not meet all the information-requirements of users. A very complex system of informal and inter-personal communication also act as additional or sometimes even the basic source of information to users. Though use of informal and inter-personal sources of information is less susceptible for quantification,their importance in information exchange activities is widely acknowledged. The most popular way of classifying sources of information is formal and informal or non-formal sources. The other overlapping criteria often used are internal and external sources, inter-personal and intra-personal sources, seeker generated sources and sources external to the seeker, personal and impersonal sources, written or documentary and oral sources, auditory and visual sources, etc. No way of classifying sources of information is fully satisfactory and the groups are neither exhaustive nor mutually exclusive. For example, participation in a conference could be both formal and informal and information obtained could be written as well as oral. Some have labelled them as semi-formal sources. There have been several systematic efforts by agencies such as APA, AIP and NIH to formalise the successful informal sources of information like exchange of pre-prints and `invisible colleges' so that the benefits of informal sources are not restricted to a small number of elite scientists and engineers.

The formal and documentary sources of information are stable, asymmetrical or unidirectional, public, permanent (or archival), retrievable with efforts, primarily user-selected, normally carry comprehensive yet relatively old information, are accessible to those with peripheral interest, reach wider audience, have information with greater accuracy due to refereeing and involves functionally defined discrete stages of production, dissemination, acquisition and use. On the other hand, the informal and inter-personal sources of information are symmetrical (two or multi-directional), spontaneous, flexible, private with instantaneous

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feedback, and tailored to exact needs. They provide detailed technique with do's and dont's, opinions and sensitive information. They are restricted to a small group of specialist participants (at times accessible only to members of `invisible college'), temporary and ephemeral in nature and often carry redundant information. Information from informal sources is difficult to retrieve later, and such sources normally carry up-to-date, nascent, pre-digested and screened information. They are faster and have very little or no monitoring or refereeing. The intra-personal source of information is the result of one's accumulated experience, thinking, results of one's own research and experiments.

11.1 Relative Dependence on Formal and Informal Sources of Information

A large chunk of research has been done at the broad level of relative dependence on formal and informal sources of information. It may be noted that in user-research, librarians have concentrated more on formal sources ignoring the below-ground network of informal incidental communications and non-librarians have mostly concentrated on informal communications ignoring the mushrooms of formal communication in organised stores (Brittain, 1971, p4; Hatt, 1976, p 96). Many studies have confirmed the importance of both formal and informal sources of information. There appears to be a neat inter-linking of formal and informal sources and each stimulates the use of the other in many situations and thus acts as a mutually supportive, dependent and complimentary source of information.

The research about formal versus informal sources of information has often been tackled with a third variable. Both formal and informal sources of information are used to meet the information-needs of scientists and engineers. Certain needs are associated with certain channels (sources), usage of which varies with job function/nature of work, discipline, professional focus, organisational affiliation/work environment, education, nationality, user evaluation of the channel, stages of the task etc. (Allen et.al.,1966; Ackoff et.al.1976, p 150). For example, mechanical engineers engaged in research and teaching made greater overall use of literature, and those engaged in practical aspects of engineering like design, testing and maintenance used data sheets, hand books, BSI documents and trade literature (Wood and Hamilton, 1967). On the other hand industrial personnel with professional focus tended to seek external personnel communication and journals as compared to internal corporate sources sought by personnel with operational focus (Rosenbloom and Wolek, 1970, p 91-92). Interestingly, the American physicists were found to have a slant towards informal sources of information and the British physicists towards formal sources[1] (Slater and Keenan, 1967, p 6). Aerospace scientists and engineers (except physicists) had mainly personal contacts with colleagues particularly those in one's own division (Raitt, 1984, p 209, 211 and 214). Defense personnel also turned most of the time to either colleagues or departmental files or personal files for information (Auerbach, 1966, p 106-107; 1965, p 1-12).

The dichotomy of scientists on the one hand and applied scientists, engineers and technologists on the other has been considered for comparison by many researchers. The general picture is that scientists are extrovert and depend more on formal sources and engineers are introvert and depend more on informal sources. Within inter-personal sources scientists contact colleagues outside-the-laboratory more than the engineers do. Such a difference is attributed to the nature of work that engineers are concerned with making things work (Wolek, 1969), the psychological traits that predispose an engineer to solve problems by himself or with the help of colleagues rather than by finding answer in the literature (Anthony, et.al, 1969), use of relatively (three decade) old basic science inputs for technological innovation (Crane, 1971, p 29-30; Price, 1965, p 553-568) and training and habituations of engineers in the use of formal information-system (Paisley, 1968, p 10-11).

However, there are some differences in the findings of earlier studies about the importance of internal and external sources to engineers. While Myers (1966, p 15) found a very high input from sources external to the firm, Rosenbloom and Wolek (1970) found a marginally higher use of sources inside the organisation. This difference probably is due to way they defined and enumerated internal and external sources. Wilkin (1981) refuted the general findings (or belief!) that engineers read less than other professionals stating that the complex relationship between engineers and their sources of information is still not well understood and findings were often interpreted out of contexts[1].

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Scientists with the intention of obtaining up-to-date information on recent developments and with least concern about simple facts, seek literature (particularly advanced monographs, research journals, handbooks, reviews, etc.), membership of `invisible colleges' and colleagues outside-the-organisation. On the other hand, engineers showing more interest in descriptions of objects, processes or methods and less interested in background theoretical reading seek information from inter-personal network within the organisations including `gatekeepers' and outside customers and vendors. Pure scientists got much less (70%) data from domestic sources than applied scientists (90%) (Bach, 1957, p 466). The dependence on formal communication increases linearly as the scientist moves away from his own area of specialisation (Crane, 1972, p 118). Interestingly enhanced reading activity in an engineer lead him to enhanced inter-personal communication and a positive correlation between oral and written communication activities was also noticed (Gralewska-Vickery, 1976, p 277). In another study (Allen, 1966, 1977) it was found that the high-performing teams made more extensive use of consultants from within the organisations though a `psychological cost' is involved for an engineer to confess to an internal source of information like colleagues and the social relations among individuals in the organisation often facilitate use of more internal sources. The perceived value, allowable acquisition time and proportion of information gained from the source (respectively related to Vroom's Valence theory, Parkinson's principle and the Law of diminishing returns/marginal utility) were found to be related to the physical distance of a source of information (Auerbach, 1965). Informal and inter-personal communication was also found inversely related to the physical distance of participants (Allen, 1966, 1977).

11.2 Formal and Documentary Sources of Information

It is interesting that the engineers do not always turn to information-sources which reward them most. They try to minimise loss than maximising the gain in turning to a particular source, exhibiting a sort of conservative attitude probably due to their objective of doing `better things' than `best things' (Gerstberger and Allen, 1968, p 271).

In a problem-solving, and decision-making situation, an engineer, first, turns most probably to intra-personal reserve supplies such as personal files, one's own head, memory and knowledge (Shuchman, 1981, p 35; 1982, p5; Raitt, 1984, p 213) (may be because of factors like accessibility, proximity and ease of use) failing which or finding it in-sufficient, next turns to informal channels such as contacting a colleague or delegating it to a colleague, internally-generated documents like reports, he then (unless withdraws from the problem or accepts the unsatisfactory situation) proceeds to formal information system like a library or information centre, with or without modifying the nature of the problem.

The ranking of formal sources of information as needed by engineers and scientists has varied widely among different studies. One study (Barber,1966) has ranked them as handbooks, classified reports, advanced texts, research journals and trade literature for engineers. For Danish - Finnish research workers it was journals (99%), books (97%), abstracts (83%), reviews (63 %) and unpublished reports (61%) (Tornudd, 1959). The rank-order for scientists and engineers of rocket fuel research is: books (96%), unpublished reports (85%), abstracts (69%), journals (67%) and reviews (25%) (Herner and Myatt, 1954). Yet another rank order of dependence of engineers on formal sources of information is manufacturers' catalogues (85%), handbooks (83%), reprints (70%), standards or specifications (65%), research reports (58%), pre-prints (37%) and patents (24%) (Davis, 1965, p30-34).

Interestingly, there appears to be a relation between citing patterns and nature of personal collection of a user and the same has not been empirically investigated by many. There is a reason to believe that what a scientist or engineer cites is likely to be in his personal files in the form of reprint or pre-print or a xerox copy or at least as notes. Rowley and Turner (1978, p 103-104) hypothesise about use of an external library and personal file and say "the size, quality, arrangement and indexing of an individuals private library will influence the nature of volume of his skirmishes with any external library or information-service".

Scientific, technical, professional and trade journals are the single most widely used formal source of information especially for keeping up-to-date by engineers. Though abstracting and

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indexing journals are valued high, they are relatively less used. Technical reports were found to be next only to technical journals in importance, but not necessarily in frequency or intensity of use[1]. Most of the user-studies of engineers and technologists have concluded the high-dependence of engineers on suppliers' information or manufacturers' catalogues or trade literature[2] (Disch, 1976, p 14.2-14.4; Davis, 1965; Wood and Hamilton, 1967; Gilmore et.al. 1967, p29, 44-45; Hanson, 1974). Engineers, in general, have made heavier use of data books and text books than scientists (Slater and Fisher, 1969, p 51). Astronomers and space scientists (that to theoreticians than experimenters and senior scientists than juniors) have made extensive use of reprints and pre-prints (Meadows and O'Connor, 1969). Though user-characteristics are not extensively related to dependence and use of formal sources of information, personal, professional and psychological attributes including attitude, status/position appear to play varying roles in predicting use of a source (Summers, et.al. 1983, p 85).

11.3 Informal, Inter-personal and Intra-personal Sources of Information

It is very difficult to say that reading is a superior way of transferring or acquiring information than hearing or other ways of transferring or acquiring information. Many studies have confirmed that informal, oral and inter-personal sources within the organisation are very important sources of information for engineers whether they are direct or indirect (two step/multistage flow), vertical or horizontal in the organisation structure (Glass and Norwood, 1959; Sherwin and Inemson, 1966; Rosenbloom and Wolek, 1970; Gralewska-Vickery, 1976, p 269). To quote an award winning biologist: "I have the impression that great body of information is getting around by a mechanism that can only be termed gossip" (Kelly, 1986, p 46). It is estimated that "professional researcher may receive upto 55% of his useful technical information by informal means" (Bodensteiner, 1970). The relatively greater role played by informal sources for practitioner is emphasised (Brittain, 1971, p 15) and several reasons were putforth. The practitioner-engineers, who normally work under the conditions of uncertainty and/or anxiety in diverse set of research areas naturally turn first to their colleagues to compare the results with other similar results (Havelock et.al., 1969 p 4-12), to get a tailor made solution synthesised to support a finding (Ackoff et.al., 1976, p 148), to have a source of confidence and reassurance, to get details concerning procedures or experiments, to cut short the lag in publication-time (Hall, 1972, p 14), to have expert assistance in locating diverse set of published material (Crane, 1971, p 30), to communicate inter-personally the complex messages (Wolek, 1970) and to fill the gap between supply of and demand for information (Kunz, et.al., 1977, p 9).

Frequent intermittent use of formal sources and informal discussions was also reported by some researchers. The more senior a scientist is, the more prolific he is as an author, and the more time he is likely to spend on informal discussions (Meadows, 1974, p 119). Journal articles were more useful to those who do not have access to the inter-personal network of their authors than members of such network and prior acquaintance with the material in journal articles is inversely related to the perceived usefulness of the articles (Lin and Garvey, 1972, p 23). Wolek (1972) found a rich period of preparatory activity preceding the actual exchange of information in informal discussions consisting of: (i) `piggy backing', i.e., storing the information-need with the hope of an accidental encounter with the required information, (ii) `friendly consultations' with the intentions of making friends known about one's interests and (iii) `professional peripheration' to get sufficient background and understanding to enable him to approach a competent person. These ways are affected by the opportunity-cost of user-time, earlier experience with similar needs and content appreciation (focusing on subject area). This explains an earlier little puzzling finding of Allen and his colleagues (1969) that R&D engineers first consulted the literature and then only used personal sources like fellow engineers.

There are no empirical studies about intra-personal sources i.e., personal experience and personal file as sources of information. Reporting the national study of American engineers, Shuchman (1982, p 5) says, "the primary source of engineering information is largely what the engineer keeps in his head (intra-personal source) or possibly knows where to find in books or catalogs in his office". But the effects of knowledge and experience are largely unconscious, and it is felt difficult to make estimate on the nature, size and value of such intra-personal sources of information (Wilson, 1977, p 61).

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As far as personal collection or personal file of engineers and technologists are concerned, a large proportion of it consists of unsolicited literature (Langrish, 1972) in the form of trade literature/catalogues, reports, reprints, pre-prints, xerox copies of papers and notes. These `extracted literature' significantly overlaps with formal sources, and as such their nature and importance has been, by and large, speculated in user-research. The proportion of reports, reprints, pre-prints and trade literature in personal collection differs significantly with the attributes of a user and his area of work. For example, engineers and technologists are expected to hold large number of reports and trade literature and scientists to have reprints and pre-prints. Within science, reprint-distribution was high in more marginal and heterogeneous specialities with a high-frequency of collaboration (which in turn indicates the presence of informal networks) (Hagstrom, 1970).

11.4 Sources of Information for Innovative Ideas

One of the less cognizant purposes of seeking information by scientists and engineers is for innovation or idea-generation. Some studies have dwelled into this aspect of user-research to determine the sources of information providing stimuli for generation of novel idea or innovative technique. The researchers are divided on sources significant for idea-generation. While some have emphasised literature (and reading activity) as the main source of innovative ideas for scientists and engineers (Scott, 1966, p 57-58; Shotwell, 1971; Moss, 1957; Langrish et.al., 1972; Nagpaul and Pruthi, 1979), others have favoured informal discussions particularly with fellow professionals outside-the-organisation (Utterback, 1969; Allen, 1965, 1966, 1968; Myers and Marquis, 1969; Baker et.al., 1967) and yet others indicated that intra-personal sources like intuition and own (previous) work as significant sources of innovative ideas (Herner, 1954; Wolek, 1970; Baker, et.al.1967). The less important sources of ideas were found to be teaching, visiting trade exhibitions, attending courses, conferences and meetings. Interestingly, more the age, the more is the dependence on literature for innovative ideas and less aged depended increasingly on informal discussions (Bernard et.al., 1963/1964, p 56-57). On the other hand, higher-levels of education of user and higher-level of research intensity of the organisation helped use of both literature and personal contacts for innovative ideas in an efficient and mutually supportive way (Johnston and Gibbons, 1975, p 27). Lastly, avoiding excessive precision discussed by Line (1974, p 48) is expressed in the following quote (Kelly,1986, p 45) from a Noble laureate that "... any normally brilliant fellow who allowed himself to be sensitive to creative ideas could, by being in the right lab at right time, luck into some awesomely simple insight. It was just a matter of hanging loose".

11.5 Variations in Dependence on Sources of Information at Different Stages of Projects

Dependence on different sources of information, naturally, was found to vary with different stages of a project, programme or activity. Preference for a source of information is dependent on task and some sources are more useful at some stages than others (Allen, 1968; Garvey, 1975). But the identification of the stages of a project differed widely from investigator to investigator and the stages identified are not mutually exclusive[1]. Rather, a scientist or engineer does not pass through the discrete stages of a project. He may be involved in more than one stage which is specially clustered in progressive direction (Garvey, 1975). Sources external to an organisation were found to play a predominant role in supplying information in the idea-formulating phase and internal sources play in the problem solving phase (Fischer, 1980). From the past studies it is clear that the information requirements of different stages of engineering projects and scientific works differ considerably. While basic science research needs literature at the later stages, the engineering projects do not essentially need the same because of lack of interpretation of results and publication activity. However, both types need an exhaustive literature during the initial phase.

11.6 Late Detection of Information, Tolerable Delay and Age of Information

An issue very much connected to information-input at different stages of a project is the late detection of relevant information and the tolerable delay in supplying information. The timeliness of information, in the broad sense, is very important for engineers and technologists. How much delay is tolerated depends on the nature of work, needs at different stages of engineering

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project and crucial nature of the information. In other words, the central issue is: can the engineer effectively make use of the late-found information without much adverse effect on cost and/or time of the project?

Most of the research in this area of late detection of information and tolerable delay are speculative in nature. Generally, engineers and technologists have tended to ignore information found late i.e., after their designs were `frozen'. The late detection can either indicate conscientiousness or laziness. Further, lateness is relative and subjective (Line, 1971, p 426). It is difficult to find reliable data about the tolerable delay (Brittain, 1975, p 433) and even assess the factors responsible for late detection of information (Skelton, 1973, p 145). Users who are most likely to detect late information are those who are conscientious in their literature-searching and infrequent users in their haphazard search find more of accidental late discoveries (Skelton, 1973, p145). Late discoveries of information might be due to harmless or harmful-costly ignorance. As the latter leads to repentance after late detection, the costly ignorance should be kept to a minimum (Wilson, 1977, p 61-63).Bernard and others (1963/1964) in their study of bio-scientists found that 40% of the youngest group and 30% of the remainder had some information which they would have liked to have had earlier in their research. Martyn (1964, p 10-13) found that out of 647 research scientists responded, 144 (22%) reported they found relevant information in the literature too late for the information to have full value. Out of 245 such instances of late discovery reported, 106 (42%) would have saved time,money and efforts, 60 (24%) would have caused alteration in research plan, 43 (17%) would have caused unintentional duplication of research and 36 (14%) would have caused major changes in the plans. Martyn also reported the sources of such late detection as recommendation by another person (not library staff) (32.7%), citations in current reading materials (17.6%), by chance while looking through publications (16.3%) and from abstract journals (12.6%). The reasons for not finding the references earlier are: not published at the time of starting research (37%), lack of systematic literature-search (21%), published in unexpected place (12%) and not available in the library (12%). He concluded that "... the performance of a literature-search is the mark of the literature-conscious and it is these people who are most likely to detect extra information as it enters their environment, they are `information-prone' (p 14). Anthony and others (1969) in their study of the use of physics literature found that time was a factor for 59% and that scientists were slightly less preoccupied with time than the engineers. Lastly, as regards the acceptability of old information is concerned, again Anthony and his associates (1969) have found that 40% of their respondents had no time limit and another 40% were willing to accept literature that were ten years old. Raitt (1984) compared this with his own finding that 29% of his respondents gave no time limit and 44% said that facts must .pa be recent.

Footnotes

[1] The importance of a source of information to a given user is not accurately represented by frequency of use or amount of time spent on it. Ranking of sources of information suffers from the disadvantage based on the assumpsuccessranked sources are at an equal distance.

[2] The use of formal (published) sources by overseas physicists is much less than that of U.K. and U.S.A. physicists (Slater and Keenan, 1967, p26)

[3] As an example, he cites that conclusions of Allen and his associates are based on the study of applied researchers to represent engineers, and books and journals to represent literature.

[4] Technical reports, often called grey literature or semiformal sources, are yet to be fully recognised as formal sources of information.

[5] Depending on the degree of dependence, anticipated value, preferred order. Trade literature has ranked from a very high to moderate dependence among different sources of information. Yet trade literature is extensively held in drawing and design offices than libraries.

[6] Atherton (1977, p125-126) identified three stages in a technology project, namely, the choice of the trend of an R&D design project, planning and execution. Lancaster (1978, p 55-56) has not only provided an exhaustive identification of various stages of a project but also reviewed the findings of major studies including that of Garvey, Allen, Rees, White, Bertram (citation analysis) and others.

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CHAPTER 12

INFORMAL COMMUNICATION-NETWORK AND COMMUNICATION-BEHAVIOUR

Establishing effective communication is the broad purpose of any information-system. Communication is not only a complex phenomenon, but also forms part of the day-to-day scientific and technical work. Stressing the crucial and great role played by informal, inter-personal and oral communication, researchers in the past, particularly non-librarians, have studied informal communication-networks and communication-behaviour (both form important adjuncts to information-behaviour studies) of scientists and engineers using different methodologies including network analysis and role theory. These studies brought forth the `transceiver' role of scientists, engineers and technologists and are very similar to multi-step flow studies of mass-communication[1]. Information-behaviour studies are incomplete without exploring the morphology of information flow, the unknowns in the communication process, how individuals communicate and the nature of communication patterns2 (Lamb, 1972 p 113-114).The patterns of communication among members of a group are referred as communication-network. The pattern is also identified from a sociogram constructed by sociometric analysis of choices indicated by respondents. It may be better to classify a subject based on its communication-structure than its contents (Pritchard, 1977) as each area of scholarship and practice may be associated with special communication-networks, and fundamentally different information-requirements (Brittain, 1971, p 11).

12.1 The measures of Communication-Network-Analysis

The network-analysis technique has been applied in many subjects and some of the measures of network-analysis borrowed from other subjects are density, connectedness, centrality and cluster (Jones, 1981, p 63). The density measures the degree to which members of a network are in touch with one another and is the ratio of the actual number of links to the maximum possible. The `connectedness' is the average number of relationships that each person has with others in the same network. The centrality of a network location is the ratio of the communication-activity at that location to the mean communication-activity over all locations in the network. The cluster is a set of persons who have many links with one another, with a density of not less than 80%. Conolly (1975, p 51) concluded from a survey comprising 115 researchers, engineers and managers at a research site of a large U.S. Federal Government agency that decision-related communication nets tend to be more centralised for applied technology planners than for basic research planners. Pruthi and Nagpaul (1978) used the criteria of the number of contacts as well as the number of choices to determine the centrality of communication-networks in two projects and found more centralised communication-network in smaller project. Based on Mullin's (1972, 1973) four stages in the development of scientific speciality, namely, paradigm group, communication-network, cluster and speciality, Jones (1981) examined several relationships such as colleagueship, co-authorship, informal communication, pre-print distribution, apprenticeship and citations among scientists working on particle emission black hole and concluded that they are between the network and the speciality in their characteristics.

12.2 Intra-and Inter-Organisational Communication

An organisation-oriented communication-network can also encompass partly individuals outside-the-organisation. The extent of such inter-organisational communication depends on the nature of the organisation, nature of work of individuals, type of information needed and so on. Wilkin (1981, p 2.10) indicated that the practitioner's role of individuals has lead them to seek more of intra-organisational communication and information from vendors and clients. In fact, Allen and Cohen (1970, p 12) have found that the performance of engineers and scientists were inversely related to their use of inter-organisational communication and directly related to intra-organisational communication. Pruthi and Nagpaul (1978, p55) also found predominantly internalised communication activity[1] within the project teams of R&D scientists and little inflow or

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outflow of information to other groups. On the contrary, Raitt (1984, p 213-214) found that engineers (21%) receive more information from outside-the-organisation than scientists (16%). These findings need further testing with reliable data. Interestingly, outside-the-organisation contacts were predominant in smaller projects than bigger projects (Pruthi and Nagpaul, 1978, p 55), aerospace establishments than international and other organisations (Raitt, 1984, p 165) and highly innovative and productive groups (particularly supervisors for useful ideas) than others (Farms, 1972; Hagstrom, 1965).

12.3 Communication Versus Performance

Though the measures of performance as well as communication are not very objective, many past studies have successfully demonstrated the relation of poor and inefficient information flow or communication to innovation failures (Rothwell and Robertson, 1975, p 393). Paisley, Allen, Frost and Whitley, Hall and Ritchie and others have established relation between high-performance and high rates of technical communication . Based on the choice of technical discussion partners, Bethell (1972, p 93) found that a high-performance in formal communication is a very significant characteristic of a communication star in the informal network of an international laboratory. Pelz and Andrews (1976, p 47) used eight different measures of communication like frequency of contact with colleagues, time spent in contacting colleagues, number of colleagues contacted, etc. and related to performance as measured by Peer's judgment, number of publications and patents held and found support to the hypothesis that contacts with colleagues stimulated performance. Thus, "high-performance and high rates of technical communication have been shown to be linked. What is not known is whether high-levels of communication cause high-performance or whether they are simply a manifestation of high-performance" (Hall and Ritchie, 1975, p 243).

12.4 Inter-Personal Information-Sharing

The inter-personal communication failures may occur due to many barriers between participants[1]. Communication is impeded by three broad types of barriers - physical, personal (social-psychological), and semantic (Davis, 1977, p 379). Information-behaviour studies have concerned themselves more with establishing contacts for communication, frequency and direction of communication. As such physical and personal barriers have been tackled in these studies. In other words, in a dyadic communication[1], barriers could be external/ physical or internal/personal. The individual's willingness to seek, receive, accept, share and give information as well as deliberately withholding or ignoring of information are important factors in communication (Rothwell and Robertson, 1975, p 396). There were efforts to inquire into the reasons or conducive conditions in a dyadic communication where two persons exchange ideas and information.

When an individual seeks information from another, a `psychological cost' is involved and inter-personal contacts involve the `reciprocity' i.e., a professional provides information in order to obtain information and his continued willingness to share information is based on mutual satisfaction (Wolek, 1984, p 226). Using the snowball technique, Collins (1974) has arrived at the population working on TEA lasers[2] at seven British and five North American laboratories. Semi-technical discussions with these scientists about the social structure of the group and how information- transfer took place revealed that one of the tactics employed while sharing information was to just answer the questions, but not actually volunteer information which gave an appearance of openness alongside an underlying secrecy. Secondly "nearly every laboratory expressed a preference for giving information only to those who had something to return" (p 181). Thirdly, the extra-scientific factors like friendship have played important role in scientific communication.

12.5 Similarities and Dissimilarities of Participants in Inter-ersonal Communication

As mentioned earlier, in the discussion on informal sources of information, a `colleague' has been a major and significant inter-personal source of information for engineers. Some interesting research has also been carried out about the attributes of such inter-personal source of information and hence `information-potential' of colleague-engineer.

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Similarity - attitudinally, culturally and behaviourally - between the recipient and the sender of message or idea or influence is a major variable in the inter-personal communication and acceptance of influence. Generally, individuals tend to seek out others with a similar background (Havelock et.al., 1969, p 5.13). A very broad yet significant finding of mass-communication research is that the ideas and information most frequently occurs between a source and a receiver who have certain similarities (i.e., `homophilies'[1]) and least frequently occurs when they are dissimilar (i.e.,`heterophilies'[1]) (Rogers, 1973, p 300). Compared to mass-communication, the participants in S&T communication have less differences and are more flexible in their roles, channels, contents and rewards (Lin, 1972). As scientist is found to interact with one or two narrow specialisations and engineer/technologist with wide variety of dissimilar specialisations (Weinberg, 1967, P 39-40), it is expected that the engineer/technologist faces problems of 'heterophily' in communication much more than a scientist.

The attributes of users which are found to contribute greatly to the similarity and dissimilarity analysis of participants of inter-personal communication are status or hierarchical rank, educational level, performance and length of experience. Status of the participants in communication process has rightly received maximum attention in user-research, but the findings are quite contradictory and confusing. Havelock and others (1969, P 5.13) as well as Vickery (1973, P 3) generally found greater communication among equi-status persons and the same was true with high-status respondents of Allen and Cohen (1970, p 16) as well as Arndt and others (1980). The lower-status persons neither liked one another nor communicated as much as higher-status persons in the studies of Allen and Cohen (1970) as well as Arndt and others (1980) but increasingly sought information from high-status persons. Surprisingly, Pruthi and Nagpaul (1978, P55) found more two-way-communication among persons of different status than equi-status2, i.e., more of vertical communication than lateral communication and in another study (Raitt, 1984, p 163-164), inter-personal communication was independent of status of participants. The status difference between participants could produce anxiety and tension where status is salient or status difference is significant. In such cases, the lower-status person may avoid contacting the higher-status person. However, in the absence of such anxiety and tension, much of the downward vertical flow is believed to flourish (Havelock, et.al., 1969, p 5.14).

Generally, researchers choose others with a similar academic level for working discussion (Bethell, 1972, p 94). Doctorates were found to communicate quite openly with each other but seldom with others (Allen and Cohen, 1970, p 16). On the other hand, while Allen and Cohen found that non-doctorates had sought socialisation and technical discussion more with doctorates than non-doctorates, Bethell found preference of non-doctorates for other non-doctorates for discussion and vice versa.

Interestingly, less experienced engineers (new hires) participated less in the inter-personal discussion networks than more experienced (veterans) but new hires had communication as frequently among themselves as veterans had among themselves. The new hires also communicated with others outside their own sections as often as veterans did. The factors which caused intensive communication of new hires were the interdependent working relations with large number of colleagues and the large number of contacts their discussion partners maintained (Gerstberger, 1971). Raitt (1984, P 163-164) had ambitiously attempted to construct a sociogram of communication among his respondents through a questionnaire. Unfortunately, he had ambiguity in the question followed by low response, limitations of data processing software and lack of background data about the population which prevented him from making meaningful analysis of dyadic relations. Yet he observed that for a majority, hierarchy or qualification/experience was the basis of contact; contacts were within the division or project in over half (53%) of the cases; and the status of the people communicated with was almost equally distributed to peer, superior and subordinate. Shuchman (1981, P 40) also found generally more intra-group contacts. But the inter-section choices for discussion in an international laboratory was 51 out of 183 (28%) (Bethell, 1972, p 47). Lastly, Farms (1972) found that members of teams with higher-performance mention one another more often than do those with lower-performance.

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12.6 Information-Potential of Scientists and Engineers for Inter-Personal Communication

It is interesting to study within a given system (say within an organisation) the information-potentiality of individuals as informal sources of information and frequency of contact/communication of given individual. It was naturally found that informal contacts in a science follows a Poisson distribution with the majority having low average rate of contact and elites whose frequencies of contacts deviated considerably from others several times (Griffith et.al.,1971, P 164-166). The frequency-distribution can also be used to find out communication stars and technological gatekeepers. Further, as the high-status scientists are particularly active in informal information-exchange, they naturally are likely to be high-information-potential (Arndt, et.al, 1980).

Crawford (1971, P 302-303) in a study of informal communication among 218 active scientists in the field of sleep research in U.S.A. found that on an average they were in contact with 3.3 persons concerning their work. These persons were contacted at least thrice during previous year. Scientists in the same area (i.e., sleep research) were contacted slightly (58%) more often than others. Further, 99 (i.e.,45%) of them were contacted by none, 23 (i.e., 11%) received 54% of all choices made and 33 scientists designated as `central scientists' initiated or received contacts from six or more scientists and on the average, they were in contact with five times as many scientists (in sleep research area) as others. In another interesting survey, Holland (1972, p 43) surveyed three organisations to find out high-information-potential individuals. He found high-information- potentials used more and different sources of technical information, and were found to be credible informal sources of information having a strong ability to associate seemingly unrelated ideas and were also approachable as others in the organisation. Naturally, high-information-potentials tended to be highly-sought after informal inter-personal sources of information. Interestingly, the scientists who were the focus of the most communications tended also to be cited most, to produce the most papers and to be read most by those in their area of research (Crawford, 1971).

12.7 The Effect of Formal and Informal Organisation and Physical Distance on Communication

Apart from the factors which are internal to the individual participants of the communication discussed earlier as similarities and dissimilarities of participants, the environmental factors such as the formal organisation which establishes the work relationship, the informal organisation in the form of social and personal relationships (often called the `gossip grapevine') and physical proximity of participants considerably affect the communication networks. The findings of the past studies on these aspects are not consistent.

Formal organisation exert a significant influence over both technical discussion patterns and the flow of critical information and conduct of research projects, but it is not the sole determinant of communication. The informal organisation has a stronger influence on the structure of the technical communication-network than formal organisation and to some degree, the informal organisation operates independent of formal organisation. In other words, the socialisation (lunch or tea time) network and the communication of research ideas do overlap (Allen and Cohen, 1970; Frost and Whitley, 1971). Changes in organisation structure, technical assignment, and the formation of project groups all tend to reduce technical communication both within the changed group and between the changed groups and sources of technical information outside-the-organisation (Taylor and Utterback, 1975, p 56).

The effect of organisational changes on communication structure showed more stability over time though personal relationship did influence the communication pattern, old pattern of communication persists for sometime, and ultimately it is influenced by the work relationship, and communication ties built up in the new group (Whitley and Frost, 1972). Pruthi and Nagpaul (1978, P 56) also found significant effect of work relationship on communication and only a marginal role of social contacts like Walsh and Baker (1971) and also discovered that more technical discussion (91% of all contacts) in smaller project than the other (79%). However, in yet another study (Bethell, 1972, p 93) the formal structure of the laboratory did not dominate the pattern of informal working communication, nor was the pattern a simple reflection of work

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group associations. Although a strong social network existed outside the laboratory, the informal working communication-network did not appear to be strongly affected by it.

Generally it is found that the communication increases with the physical proximity of the participants and a generalised inverse square law, similar to that stated on use of library, is often stated as: `the frequency of communication within an organisation, between two individuals, is inversely proportional to the square of the distance between their work stations' (Allen, 1970; Rowley and Turner, 1978; Allen and Fusfeld, 1975; O'Gora, 1968). Nearly 60% of the communication contacts were with people in the immediate vicinity in another study (Raitt, 1984, p 164). But Frost and Whitley (1971), Evans and others (1974) as well as Tomlin (1981) found that distance does effect on the rate of communication, but they disagreed with the estimations of Allen and his associates. They found that scientists and engineers do have strong reasons such as operational needs of project to overcome the distance barrier to communication. Frost and Whitley (1971) found that the fall off of communication at asymptotic rate occurred at about 170 meters. On the other hand, Hall and Ritchie (1975, P 243-244) found that the organisational structure was the main factor influencing the flow of technical communication and `the physical separation between scientists was not found to be an important factor in determining the frequency of communication'.

12.8 Means to Increase Informal Communication

There were many suggestions in the past about fostering and facilitating communication within the organisation as well as with outside-the-organisation. Menzel, Lickert, Pelz and Andrews, Lin, Allen, Lorsch and Lawrence have proposed several measures. Menzel (Columbia University, 1958, p167-172) suggested that the frequency as well as usefulness of informal communication can be increased by formal arrangements such as seminars, colloquia, common lunches, coffee hours, journal and discussion clubs, proper spatial arrangements and time schedules and appropriate composition of staff taking into consideration age, status, size and organisation of teams, interests among colleagues, presence of some men who have access to scientists elsewhere and those who attract visitors from elsewhere. He identified that the communication with `outside-the-organisation' can be enhanced by facilitating meetings, conferences, official visits, correspondence and many subsidiary positions and secondary affiliations such as membership of committees, journal editorial boards, visiting lecturership, etc. He also cautioned that promotion of informal communication should not be at the cost of productive time of scientists and engineers. Likert (1959, p194) through his `Linking Pin' concept has advocated appropriate formal organisation structure so that at least one member of every organisation unit should also be a member of the organisational unit immediately higher in the organisational hierarchy i.e., a sort of overlapping groups in the organisation structure. Pelz and Andrews (1976, p53) found that frequent contacts with many colleagues seemed more beneficial than frequent contact with just a few colleagues. Similarly, having many colleagues both inside and outside one's own group seemed better than having many colleagues in one place and just a few in the other. As far as the physical barriers to communication are concerned, the studies have suggested a proper architectural layout of the organisation and spatial location of persons in congruence with organisation structure, liberal tours, travels, long distance telephone and other facilities, job mobility to facilitate informal communication.

12.9 Communication Stars, Technological Gatekeepers and Isolates

Informal communication studies in science and technology indicated that there exist a few elites or cosmopolitans with higher visibility, productivity, performance, expertise who tend to be high communicators. They also act as persons bringing information from outside-the-organisation. They are considered as high-information-potential persons by colleagues[1]. Further, it is found that a population of size `n' approximately contains square root of n elites[2]. In S & T information studies different names have been used to describe these elites. The most popular of these are `technological gatekeeper'[3] (first used by Allen) and `communication star'. The other closely related terms are `special communicator', `star', `information gatekeeper', `information star', `sociometric star', `discussion star'[1], etc.

There is no uniformity among different studies in defining `communication star' and `technological gatekeeper'. The most important differences in definitions arise about the

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scope whether to include communicating activity or information-seeking activity or both, and whether to consider external communication or internal communication or both. Even the process of identifying `communication stars' and `technological gatekeepers' in a system has widely varied depending on criteria such as frequency and intensity of communication, professional activities like memberships in professional organisations, number of papers published, number of patents held, choices of colleagues for technical discussion, etc. The most commonly used definition of both technological gatekeeper and communication star, as propounded by Allen is a person who has received or communicated technical information one or more than one standard deviation above the mean level of communication of the group or the mean number of technical choices or the mean number of contacts[2]. The difference between a `communication star' and a `technological gatekeeper' is that the `communication stars' appears to play a role in in-house communication and become `gatekeeper' if he also links the laboratory with external environment.

The definition, scope and characteristics of `communication stars' have varied from researcher to researcher. The salient features of `communication stars' (in addition to those mentioned already) are that they make a greater use of information-sources such as literature and professional community outside-the-organisation. They are well-educated senior members or first-line supervisors. They are a potential-source for technical advice and consultation in the organisation and they facilitate the flow of information from outside and transmit the information to their colleagues. Further, their presence in a work-team is likely to increase the performance of the team and the probability of success of the project. Katz and Lazarsfeld (1955, P 119) have identified three types of roles played by gatekeepers namely, originator of ideas, transmitter of ideas and persuader/influential in stimulating adoption of ideas.

The `communication stars' and `technological gatekeepers' are contingent to an organisation. They cannot be instantaneously hired or created. Their extinct leads to a natural and slow evolving of new stars/gatekeepers (Fisher and Rosen, 1982). What Allen and other researchers have concluded is that `communication stars' and `technological gatekeepers' are identifiable distinct transceivers. They should be given official recognition and gatekeeper culture should be promoted. However, it is important to note that many subsequent researchers have considerably differed from Allen and his associates. Taylor and Utterback (1975, p 81) confirmed that the gatekeeper's role is a consequence of outstanding technical performance. But they also observe that most of the studies are done in aerospace and related industries where the state-of-the-art is changing rapidly and the demand for current-information is great and the need for `gatekeepers' may not be there in a more placid technical environment. The `star', `gatekeeper' or `key person' did not stand out clearly as an important actor in the informal network of American industrial engineers (Shuchman, 1981, P 48). Surprisingly, Raitt (1984, P 258) also did not find `gatekeepers' in his study of scientists and engineers of international as well as national aerospace establishments. Replicating Allen's work in an English industrial laboratory, Frost and Whitley (1971) found that the organisational rank and formal work group membership rather than the `gatekeeper' role determine the choice of an individual as a source of technical information. Similarly, Walsh and Baker (1971) as well as Hall and Ritchie (1975) have differed from Allen though all of them could identify persons fitting Allen's definition of gatekeeper.

Bethell (1972) found an almost similar network of informal working communications in an international laboratory as compared to national laboratories studied by Allen. He also discovered that a higher grade and high performance in formal communications and longer service appear to be significant characteristics of stardom (communication star) but not greater age and higher academic qualifications. In this case the communication stars did not try to monitor external environment as found in case of `technological gatekeepers' of Allen but tried to interpret the internal environment to others. Further, complete isolates did not seem to appear in this laboratory. Katz and Tushman (1981, p 104) found no evidence that the `gatekeeper' enhances project-performance. It is not always clear how to identify `gatekeepers', whether an organisation can exist `without gatekeepers', whether their role is permanent or transient, whether the intrinsic worth that makes one a `gatekeeper' or it is contingent to the environment and whether or not their positions can be formalised (Pearson, 1981). Pruthi and Nagpaul (1978, p 55) found that the `gatekeeper-construct' gets diluted with the increase in team size. Hall (1972, p 158-166) found that discussion stars are more likely to read scientific journals,

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to have personal literature-collections and to use information-centres or special sources of technical information outside their company than others.

12.10 Invisible College

Invisible college[1] is now recognised as an informal communication-network composed of scientific elites specialised in a research area and belonging to different organisations and even countries, communicate with each other via telephone, correspondence and professional meetings, exchange pre-prints, reprints and draft proposals (Lancaster and Smith, 1979, p 377). It is found that the information spreads rapidly and efficiently through such a community cutting across organisational and geographical barriers. The members of the invisible college are found to collaborate in research, constitute a power group, control personal prestige and the fate of new scientific ideas and decide general strategy of attack in an area. The number of members in an `invisible college' is approximately equal to the square root of the total population of people in that area of research front (Price, 1971, P 74), i.e., roughly same as the number of elites in the population. Extensive research is done on this phenomenon during the last three decades.

Realising the importance of informal communication in S&T information-transfer and the consequent significance of `communication star', `technological gatekeeper', `invisible college' and other phenomena, there have been concerted efforts by professional bodies like APA, AIP, NIH, etc., as well as individuals to formalise the informal communication or at least to support the informal communication among researchers. Such experiments were partly successful though a thorough implications of formalising informal communication are not determined yet. However, it is also clear that formalising informal communication is not so simple as it appears and it might run the risk of inhibiting the very kind of informal communication pattern (Menzel, 1966, p 1002-1003; Katz and Tushman, 1981, p 109).

12.11 Formal Communication-Behaviour

Apart from intensive informal communication-activities, one of the fundamental instincts of scientists is to write and publish and make their research findings known widely among fellow professionals as well as establish priority for their findings. The publishing patterns of scientists has been extensively investigated. Generally, the number of scientists who produce x papers is found to be proportional to 1/x2 (Lotka's law). As such the elite phenomenon holds good, to some extent, in even formal communication-behaviour. In other words, the productivity of papers published assumes a highly skewed distribution following the usual Matthew effect, inverse law or 80/20 rule. Although cosmopolite groups produced more information in the form of papers, articles, etc., the less research oriented localite group showed a greater likelihood to communicate downward and therefore formed important links in the flow of scientific information (Lingwood and Mc Anany, 1971, p(iii)).

The publication rate of a researcher is often taken as a measure of his expertise, performance and productivity. But there were divided opinions on this aspect since publishing varied widely between groups. Shockley (1957, p 279) one of the co-winners of the 1956 Noble Prize in physics said "scientific productivity is difficult to study quantitatively, however, and relatively little has been established about its statistics". But there has been a high or moderate correlation between quantity and quality of research published as well as between quantity of publications and the rewards and recognitions received (Cole and Cole, 1967, p 377 and 390).

In case of engineers and technologists it is the semiformal publications such as reports which are more common than archival publications (Shuchman, 1982, p 5). Due to their heterogeneous and developmental nature of work, counting of publications is not well-accepted as a measure of performance among engineers. They are even accused of publishing for the sake of publishing if they publish more than eleven papers per year (Putt, 1981, P 65). It is not totally ruled out that prolific writing might lead to negative reward in case of engineers and technologists. Yet their limited formal communication activities are useful guides for understanding their information-behaviour.

The consumption to production ratio of information and publications is much higher in case of engineers and technologists, i.e., a large number of engineers depend on the information-output

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of a few (Shuchman, 1982, P 5). It may be noted in this context that apart from many problems of formal communication like delay in publishing, language barrier, etc., the `information-overload' appears to be an ever increasing severe problem contributing more and more to reduction in consumption of information by a user. This problem of `access to excess' and the resultant handicap of too much of information has been felt from a very long time. This problem basically exists in the mind of a user and causes stress, and frequently results in increased error. It is no wonder if 90% of all scientific papers are unread by anyone but their authors (Longuet-Higgins, 1970), and if one says that it has become cheaper to conduct an experiment to find something out, rather than to attempt to discover whether the experiment has previously been performed (Kemp, 1976, p 131).

The inevitable duplication, the deliberate redundancies and re-presentations of information further aggravate the problems of `information-over-load'. Increased specialisation, increased delegated approach and more efficient ways of processing information with greater selectivity, evaluation, review and synthesis are the solutions put forth. However, the concept and problems of `information-overload' have not yet been systematically investigated. Interestingly, scientists who had published in the past five years did an average of 10.2% more reading in scientific journals than those who did not publish (Case Institute of Technology, 1960, p 19).

It was found in an Indian survey (N P Rao, 1966) that the optimum size of an R&D laboratory for maximum production of papers is 250 persons, and laboratories other than equipment-intensive laboratories showed greater output of research papers. It was also found that the organisations in high-technology industry had the highest number of patents, papers and elite scientists. The number of elite scientists was a good predictor of publication-behaviour. Further, a linear inverse relation was found in a recent study (Halperin and Chakraborthi, 1987, p 173-174) about the size of the firm and productivity of papers and patents i.e., large firms were less efficient than smaller firms in both publication of scientific papers and patenting.

Apart from the publishing patterns of scientists and engineers, several studies have been carried out about their citing, co-authorship and collaboration patterns. In fact, many have adopted citation-counts for user as well as use-studies. "The reliability of citations as indicators of use is questionable" (Ford, 1977, p 12) and fallacies about how people use information and what they cite were pointed out by many (Herner and Herner, 1967, P 24). One of the recent experiments concluded that "...the usefulness of citation-counts has been opened to serious doubts (Martin Jr., 1978, P 103).

Though some have gone to the extent of assessing the quality of a research laboratory's work by citation-counting, (Nature, 1970, p 219; Brook, 1960) many moderators (Brittain, 1970) have looked at citation-studies as an useful adjunct to user and use-studies[1]. "It is tempting to assume that the network of informal communication ties which are built up between scientists will be formally enshrined in the citation-profiles of publishing authors" (Cronin, 1982, p 220).

Unfortunately, various assumptions of citation-studies are less relevant for technology where there is a lack of cumulative growth, and typical papers in technology do not contain references to earlier works (Price, 1970). In a citation-study (Waldhart, 1973) of engineers it was found that the rank order of frequency of document-forms cited is: (i) Society Proceedings and Transactions (ii) R&D Journals (iii) Monographs (iv) Trade Journals (v) Handbooks and other reference works as well as conference proceedings and symposia. An evaluative study (Herner et.al., 1979, p 21) of GSFC library based on citations in 66 randomly selected recent journal articles showed the following rank order of citations: (i) Journal articles (73.8%), (ii) Books (10%), (iii) Reports (6.7%), (iv) Conference Proceedings (5.2%), (v) Private Communications (1.8%), (vi) Theses (1.5%), (vii) Pre-prints (1%) and (viii) Patents (o.1%). By and large, citations to reports were negligible (more so with scientists than engineers). For example, physicists made less than 3% (Burton and Green Jr., 1961, p 35), Indian engineering scientists (B.N. Singh, 1981, p 179) made 5.3% and Indian building researchers (Srinivasan, 1970) as well as American space scientists (Herner, et.al. 1970) made 7% citations to reports. In-house and self-citations were found to be considerable. It is estimated that nearly 10% of all citations are self-citations (Meadows and O'Connor, 1969, P 160). The rank order of document-forms cited by Indian scientists and engineers do not differ very much from others (Sridhar, 1985, p 261; Srinivasan, 1970; Shalini and Chudamani, 1978, p 103; B N Singh, 1981,

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p 179). But, generally, Indian authors had oriented locally for publishing and cited heavily from foreign sources. Conferences are found more as opportunities for disseminating and transferring information than as sources for citations. Lastly, the Indian authors have more self-citations than others. There is a slight positive correlation between publishing in and citing from a journal. However, the use of a journal is found independent of publishing and citing (Sridhar, n.d., p 4).

Though the co-authorship relations arise out of formal communication-behaviour of authors, they are believed to lead to a lot of informal contacts between co-authors beneath the formal communication. The publishing of papers is only a discernible output of the contacts and collaboration among co-authors. It is fairly established that a lot of exchange of ideas, thoughts and information take place among co-authors before finalising a paper. Such contacts might improve the social relations among co-authors and may become a lasting bond for future informal and inter-personal contacts.

As far as co-authorship and collaborative research among scientists and engineers are concerned none of the studies1 have tried to use co-authorship-relations as a basis for informal communication. The background of co-authors like status, specialisation, qualifications, etc., have not been compared and analysed. Nor the co-authorship linkages have been checked against citation linkages. Most of the past co-authorship studies have taken a particular discipline or area of work as their domain and not an organisation or a group of scientists and engineers.

Inspite of many limitations, some general findings of co-authorship-studies are worth noting. There appear to be many types of co-authorship and collaboration like teacher-student, superior-subordinate, guide-researcher, etc. The major drawback or limitation of such studies is that the practice of simply adding names of senior colleagues to papers of junior colleagues without any division of labour or collaboration.

It is known that over the centuries solo-research has been replaced by team research and the co-authorship trend has shown considerable increase during the present century. Yet, owing to basic human nature, some solo-research is bound to continue. Some of the factors associated with increased co-authorship and collaborative research are external financial support, sponsored research, popularity of subject, professional dependence, etc. The co-authorship and collaboration phenomenon is explained as a rationalisation of manpower shortage in a rapidly expanding science with consideration to make the best use of low or moderately productive scientists (O'Connor, 1969).

It is generally found that the number of papers with `n' authors is inversely proportional to `n-1' factorial except for two-authored papers (Price, 1966, p 1013). Interestingly, it is also found in the past that (i) the more the authors of a paper, the higher is the rate of acceptance of the manuscript for publication (Gordon, 1980), (ii) collaboration and productivity are correlated i.e., the most prolific authors tend to collaborate most and vice versa (Pao, 1980; Sridhar, 1985), (iii) co- authorship and collaboration is higher in basic disciplines than in applied disciplines (Frame and Carpenter, 1979) and (iv) awards and prizes to an author create strain within collaborators and are likely to disrupt the stability of co-authorship and collaboration network (Zuckerman, 1967).

Footnotes

[1] The important differences are that informal communication is more audience motivated, the links are more cognitive and the messages often precede the appearance in print in S&T than in mass-communication.

[2] To study citations is far easier than studying people" (Rowley and Turner, 1978, p 45)

[3] Communication in this study is characterised by its nature, frequency, whether external or internal to the team and time spent on it.

[4] Man is better characterised as a bottleneck than a channel of communication (Miller, 1956).

[5] Dyadic unit is one that describes the combined actions of two persons. Though originally Sears used the dyadic unit to refer to more than two persons also, the dyadic relationship implies relationship between two (Sears, 1951, p 475).

[6] Transversely Excited Atmospheric Pressure Carbon Dioxide (TEA) lasers.

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[7] Homophily' refers to the degree to which pairs of individuals who interact are similar in certain attributes like beliefs, values, education, social status etc. `Heterophily' is the opposite of `Homophily' and it refers to the degree to which pairs of individuals who interact are different in certain attributes (Rogers, 1973, p 300).

[8] The status here was determined both by educational qualification and position in the organisation hierarchy.

[9] These elites are very similar to opinion-leaders or word-of-mouth specialists of multi-step flow model of mass-communication. Blaivas (1982, p 268-269) and others studied scientific elites and the perception of eminence by snow-ball technique based on peer nomination and concluded that the degree of consensus is high in tightly structured, self-contained and well-defined fields. For newer and less structured,more diffuse fields, there are some highly regarded individuals, but otherwise nominations are more scattered. The stability of eminence is perhaps a major difference between hard and soft sciences.

[10] This approximation was done by Price (1971, P 74) by extending the arguments from Bradford's law, Zipf law and Mandelbrot's law.

[11] Lewin (1947) has first used the term `gatekeeper' in a study of marketing-behaviour with mother as `gatekeeper' to the food information channel of the family. He has also used the term to describe persons such as editors of newspapers and journals.

[12] Holland (1974) provided an interesting comparison of these terms together with opinion leader, innovator, early adopter, persuasive source, elite few, internal consultant, linker,etc.

[13] Allen has also defined `isolates' as those who do not communicate with others, are not approached by others, prepare fewer written communications and are significantly less in contact with the outside environment.

[14] The term `invisible college' was formally first introduced by Price in 1961 though the phenomenon existed for a very long time.

[15] Citation-indexing has been considered to be an example of `constructive sociology' (Kochen, 1967, p 139).

[16] A Japanese study (Miwa, 1982) and an Indian study on the space technologists (Sridhar, 1985) appear to be exceptions.

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CHAPTER 13

USE OF LIBRARY AND USER-INTERACTIONS WITH LIBRARY

There have been many user-studies of libraries but only a few have interpreted user data to infer information-behaviour of users. Majority of use-studies have analysed what is used, frequency of use, lifetime and obsolescence rate of material used etc., with varied objectives. At the most, they were thought of as demand- studies. User-interactions with libraries did not receive enough attention ? in user-research. The critical incident data of specific demands made on typical libraries should reveal behavioural trends, and indicate their underlying motivation better than a theoretical and qualitative investigation (Slater and Fisher, 1969, p 1).

At the outset, it should be made clear that the use of a document or library does not imply its utility or usefulness. Nor does a high or intensive user-interaction with the library necessarily imply that the user is an intensive user of the library or a highly library- dependent user. "An information-system may be used, then, but not be useful; it may also be useful, but not used. It may even be neither useful nor used. It is ideal if it is both used and useful" (Kochen, 1976, p 150).

Depending on the intensity of use, the users are classified as `High Information-Potential' (HIP) and `Low Information-potential' (LIP). LIPs are further divided into (i) the NOSTALGIC, who would like to keep informed but never have time, (ii) the BEREAVED, who think it is now too late to update themselves and (iii) the LOST SOULS, the confirmed non-users (Shuchman, 1981, P 1). Secondly, the number of users who have need of information far exceed those who actually use information (Atherton, 1977, p 7). At the same time, it should also be noted that the services of libraries are not restricted to those actually use them, but reach others via actual users due to `spillover effect' (Wilson, 1977, P 83). As a matter of fact the LOST SOULS (among engineers) might be heavy users of information in different forms (Shuchman, 1981, p 23). Thirdly, the "...concern with users should not be equated with an objective of maximising use (sales)" (Oldman, 1976, P 37). Lastly, it is not yet established that the use of libraries has any definite influence on anything else (Ford, 1977, p 101).

13.1 Use of Library and Library Documents

One of the ways of exploring information-seeking behaviour is to study the actual incidents of use of information and documents is users. By and large, the use of library is a `minority event' i.e.,a very small segment of rightful members really use their `primary library'. Like insurance, for a majority of the engineers and technologists the library appears to be a necessary adjunct to the regular work without much direct consequence attributable to the existence of the library. However, its absence is normally felt by some marginal users too. The studies of Shuchman, Scott, Gilmore and others, Slater and Fisher and that of `The Social Survey' have very much shown this aspect. For an example, `the social survey', in its survey of U.K. electrical industrialists found that in case of those firms which had a library less than half of them used it and 18% of the respondents said that they did not use libraries of any kind (Scott, 1966, P 36). Similarly, in the case of Slater and Fisher's survey (1969, P 21) the ratio of potential-users of library to total membership was 26.3% for industrial firms and 22.6% for government establishments. Surprisingly the same was as high as 69% in an Indian study (Sridhar, 1985, p 31-32). A study of science library at MIT (Bush, et. al. 1956, P 94) showed that the ratio of visits to enrollment as 0.37 and Shuchman (1981, P 30) found technical libraries serving only a small proportion of the engineers. When the use of library documents is examined we find that still smaller segment of users use library documents typically following the 80/20 rule.[1]

Just as inter-personal communication follows the inverse square law, the amount of use of a library is also inversely related to the square of the distance between the library and the functional group to which a user belongs (Frohman, 1969). Yet the psychological distance may be more important than physical distance (Line, 1974, p 48).

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Among all types of documents, `use of journals' has been studied by many with different ethodologies. It was found in these studies that a major portion of the reading of the scientists, engineers and technologists is in journals (Shaw, 1971, P 23-24, 32-35 and 81-82). In journal-reading behaviour, "issues" like how many journal a user regularly reads, how much time he spends on journal reading, the place of reading journals and the factors which affect journal reading have also been investigated. Though the findings are almost unanimous that a user can cope up with his filed by reading few journals, the average number of journals actually read varied widely. In Menzel's study (Columbia University, 1958, P 135), three most important journals accounted for 0.49 fraction of articles read by research scientists. Two surveys of Case Institute of Technology (1960), p 12) showed that ten mostly-read journals accounted for 55.1% and 49.8% of the chemists' journal reading time respectively. Many studies have confirmed that an average scientist/engineer/technologist reads 5 to 15 journals while normally a scientist reads more journals than an engineer or a technologist (Scott, 1959, P 113; Martyn, 1964, P 20; Bernal, 1948; Martin, 1962, p 98; Wood and Hamilton, 1967; Gralewska-Vickery, 1976, P 274; Hanson, 1964, p 65; Ford, 1977, p 32). The use of books and other documents of library have very widely varied from library to library, from subject to subject, and no generalised conclusion except 80/20 rule cited above can be made as far as user-behaviour is concerned.

13.2 Correlation of Use of Library Documents With User-Characteristics

The correlation of use of library documents with user- characteristics has not always shown consistent results. Interestingly, a person who saw more journals tended to be active in many ways like attending more meetings and conferences, actively engaged in the work and having better qualifications (Scott, 1959, p 28).

First of all, the use of library documents is found to vary with the type of organisation and users. Those employed in government establishments and industries have made relatively less use of library (and journals) than those employed in academic and non-profit organisations (Slater and Fisher, 1969, P 15; Meadows and O'Connor, 1969). The analysis of use of library in science subjects versus engineering/technology is found to be fairly close to that of scientist versus engineer/technologists pattern i.e., scientists particularly those in research made more use of libraries than engineers and others (Case Institute of Technology, 1960, p 21). Surprisingly, the average number of documents consulted by scientists (3.9) was lower than that of engineers, but the used to useful documents ratio was more favourable for scientists. The pressure of time bothered engineers slightly more than it did scientists, but slightly less than it did non-technical personnel. Technicians were found to be underprivileged group in the information-complex (Slater and Fisher, 1969, p 17-18 and 50).

The use of library documents (and Journals) was found to be linearly and positively related to age and experience of users as per studies of Scott (1966, p 28), Lipetz (1970), Fearn and Melton (1969). However, beyond the age of 45 years and 10 years of experience the use was found to decline. But the opposite (i.e., negative relation) was found in studies like that of Bath University Library (1971), Barkey, (1966) and Ford (1977, P 93). Women space technologists did not differ from men in making borrowed use of library documents but differed significantly in in-house use and interactions with the library (Sridhar, 1987). Again the use of the library was found to be positively related to the level of education of the users (Scott, 1966, P 16; Lipetz, 1970; Fearn and Melton, 1969).

Creativity, performance, excellence in work and publication activities are also found to be positively related to use of libraries (Lufkin and Miller, 1966, p 180; Case Institute of Technology, 1960, p 21). However, a recent study found no strong relation between use of libraries and academic performance of users (Hiscock, 1986). In addition, high status scientists and engineers tended to use more of library materials and subscribe to more journals (Shaw, 1971, P 17,20, 48-49) and managers and supervisors, particularly those in research and production areas, tended to read more journals than others (Scott, 1960, p 28).

13.3 User-Interactions With LIbrary

Like `use of library', user-interactions with the library is also a phenomenon of a minority of users. In fact, both the use of library and the user-interactions with the library are highly

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interdependent and related. However, there is not much work done about user- interactions with the library. What is available in literature are fragmentary stray attempts to study some interactions of users with libraries. This may be partly due to the time-consuming observation technique to be followed for the purpose. For the same reason many use-studies also did not venture to consider the in-house use of library documents.

A user visits the library for many purposes. Interestingly, Slater and Fisher (1969, p 29) found that 38% of their respondents visited their libraries for work space (11% exclusively for work space). Even in the study of science library at MIT (Bush et.al., 1956, P 88) a considerable number of persons used the library only as a study hall to make use of their own material. On the contrary, Scott (1959, P 113) found that 59% of the respondents claimed to do most of their journal reading at home followed by 27% at place of work, 2% during journey on train, 3% in a library, 1% in other places and 2% of the respondents did no reading of technical journals. In a study of in-house use of library documents and seat occupancy, the space technologists were found to visit the library more during departmental reviews for promotion. The distribution of user-visit data over a typical day was bi-modal, roughly symmetric and the same was cyclical over a typical week with maximum during mid of a working week (Sridhar, 1982). Like use of library documents, the reservations made by the space technologists for lent-out documents followed skewed distribution and year of acquisition of a document had a stronger effect on its chances of getting more reservations than year of publication (Sridhar, 1983). In another study, it was found that less than one-fourth of the space technologists have had participated in collection development of the library (Sridhar, 1983). Yet another case study showed non-use of classified catalogue, heavy use of subject catalogue and a roughly symmetric bi-modal distribution of card catalogue consultation over a typical day by the space technologists. Further, card catalogues are consulted most of the time either to locate a document on the shelf or to interact with the circulation counter than for literature search (Sridhar, 1986).

There are no comparable results of earlier research about specific aspects of user-behaviour within library as far as scientists, engineers and technologists are concerned. Most of the findings of user movement/traffic,card catalogue-consultation, in-house use, length of stay, seat occupancy, etc., are that of academic or public library users. Apart from science library at MIT mentioned above, Pings and Anderson's (1965) study of user movement/flow pattern, the study made by the University of Cambridge Library Management Research Unit (1975) about seat occupancy, and Campbell and Shlechter's (1979) study of library design influences on user-behaviour are some of the studies in this direction.

Footnote

[1] The ways in which library documents are used is not very clear. It was found in INFROSS study (Line, 1971, P 422) that users are equally divided on the preference to use library documents consecutively and conjunctively.

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CHAPTER 14

SOME OBSERVATIONS BASED ON REVIEW OF SELECTED LITERATURE ON USER-RESEARCH

User-research in science and technology area has necessarily occupied a considerable bulk of literature in library and information science with some inconsistencies, less consolidation and relatively less usable findings. There is a dire need for `meta analysis'[1] of the literature. Most of the user-research has been carried out in U.S.A., U.K. and other European countries. The developing countries and under-developed countries in general and India in particular almost totally lack sound user-research. What is seen in the literature of Indian librarianship is either theoretical `repackaged' information or unpublished surveys made by students of library and information science. No single major user-study in the area of science and technology is done in India. Systematic, continuous, localised and comprehensive user-studies preferably by information-men `living with the tribe' are very much lacking. Further, the contingency nature of findings of user-research do not allow for borrowing/importing them from developed countries.

User-research in general has not paid enough attention to information-behaviour of engineers and technologists as compared to scientists. The lower-level technicians have been almost ignored. The information-behaviour of high-technology workers like space technologists are not explored fully. Although some `applied' aspects of information-behaviour are extensively investigated, the `basic' aspect of user-research (i.e., why a user behaves as he does), unambiguous definition, probing and discussion of theoretical concepts and frameworks and many other aspects like co-authorship patterns and its influence on informal communication, `homophily' and `heterophily' phenomena in communication, comparison of citation linkages with co-authorship and informal communication linkages, user-interactions with library, the problem of `information overload' or `access to excess', etc. remained largely unexplored.

Many more information-user-characteristics like personality traits and psychological dimensions of users are yet to be identified and related to information-behaviour of users. Most of the correlations of user-characteristics with specific aspects of information-behaviour are speculative and theoretical in nature rather than based on a rigorous analysis of hard data. Inter-correlations of various aspects of information-behaviour as well as user-characteristics are almost neglected.

Significant work in the area of user-research has been done by non-librarians. Yet there is a lack of an integrated and inter-disciplinary approach to the subject.

Above all, there is a greater need for use of more imaginative methodologies and advanced statistical techniques in user-research. Hardly anybody has ever used indirect projective techniques (similar to that used by psychologists) in user-research.

From the review of literature presented, one would conclude that there exists much ado about need for user-research, speculative findings, claims and counter claims occupied in a large volume of literature with least consolidation and cumulation. The vast scope for further research in terms of different segments of users, different aspects of user-behaviour and attitude with refined methodologies and rigorous analysis of data still remain unexplored. There also appears to be an overemphasis on generalisation of findings of user-research (ignoring finer details of smaller groups of users and their uniqueness) as well as on citation and use-studies.

Footnote

[1] Meta-analysis is a methodology quantitatively cumulating and integrating findings across studies (Gooding and Wagner, 1985, p465).

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